CERTIFICATE OF MAILING BY "EXPRESS MAIL" UNDER 37 C.F.R. § 1.10

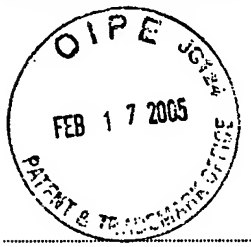
I hereby certify that this Petition and supporting documents are being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 in an envelope addressed to: Assistant Commissioner for Patents, Box DAC, Washington, D.C. 20231 on:

Date: 8-29-02

James L. Farmer
Typed or Printed Name of Person Depositing

Signature: James L. Farmer
Signature of Person Depositing

(Express Mail Mailing Label Number)



UTILITY PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Osman Attorney Docket No.: 003.0001

Serial No.: not yet available

Filed: March 27, 2001

For: SQUARE ULTRA THRUST REVERSER

PETITION TO ACCORD A FILING DATE UNDER 37 CFR 1.53

Assistant Commissioner of Patents
Box DAC
Washington, D.C. 22031

Honorable Assistant Commissioner:

The applicant, Mr. Osman, wishes to obtain the filing date of March 27, 2001 for a non-provisional application, which was previously submitted to the US Patent and Trademark Office by the applicant, but apparently not properly received or entered by the PTO because no filing

receipt was sent. Applicant has up until to this point represented himself in this matter, and has now appointed me to act on his behalf. The facts are as follows:

Mr. Osman filed a provisional patent application entitled "SQUARE ULTRA THRUST REVERSER" in March, 2000. Mr. Osman subsequently received a filing receipt indicating the application had been granted a filing date of March 27, 2000, and a serial number of 60/192,337, and that the application included one drawing. With the filing receipt was a Notice to File Missing Parts, which applicant responded to in June of 2000 by filing a statement claiming small entity status. Copies of the Provisional application, Filing receipt, Notice to file missing parts, and small entity statement are enclosed herewith. A copy of the drawing that was part of the provisional application is not included, but could be retrieved if needed from the Applicant, or alternatively from the PTO file wrapper.

In March, 2001 Mr. Osman submitted to the PTO by Certified US mail a non-provisional patent application, properly addressed to the Assistant Commissioner for Patents. The application contained a specification containing description pursuant to 37 CFR 1.71, two claims pursuant to 37 CFR 1.75, and a number of drawings pursuant to 37 CFR 1.81(a). The application also included a reference back to the earlier filed provisional application, along with a check in the amount of $250.00 for the filing fee. Mr. Osman subsequently received the certified mail receipt, date stamped by the PTO Mail Center as having been received March 27, 2001. Mr. Osman has received no further communication from the Patent office regarding the non-provisional application. In November, 2001, Mr. Osman submitted a revised copy of the first page of his non-provisional patent application containing a new home address, along with a cover letter dated November 1, 2001. Again no response was received from the PTO. Copies of the Non-Provisional application, and the date stamped Certified Mail receipt are enclosed.

In May, 2002, Mr. Osman contacted a Ms. Velora Dillard at the PTO, requesting her help with the non-provisional filing date. Ms. Dillard subsequently contacted me, however she was unable to locate the application, and recommended to me that Mr. Osman petition for the filing date.

In view of the foregoing, Applicant submits that a complete non-provisional application was properly submitted to, and received by the PTO, as evidenced by the certified mail receipt date stamped March 27, 2001. Applicant further submits that the non-provisional application included adequate reference to the earlier filed provisional application. Applicant therefore respectfully requests that the non-provisional application mailed in March 2001 be accorded the filing date of March 27, 2001, and granted priority to the provisional application S/N 60/192,337 filed March 27, 2000.

Also enclosed herewith is a revised claim set that applicant wishes to have replace the two claims in the non-provisional application as originally filed. Applicant submits that the new claim set is fully

supported by the specification and drawings of the non-provisional application, and that no new matter is added. In the event that the Examiner cannot accord the filing date of March 27, 2001 for the non-provisional application as requested, Applicant hereby requests that the copy of the non-provisional application and revised claim set submitted herewith be considered as a new application filed as of the Express Mail date of this petition.

Should the Examiner wish to discuss any of the above in greater detail, please telephone the undersigned at your convenience.

Respectfully submitted,

Date: 8-29-02

James L. Farmer
Registration No. 42,525

511 East Concorda Dr.
Tempe, Arizona 85282
Telephone: (480) 894-2517
Facsimile: (480) 785-4491

IFW: 3746

PTO/SB/21 (09-04)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Application Number	10/042,737
Filing Date	Aug 29, 2002
First Named Inventor	Medhat A. Osman
Art Unit	
Examiner Name	
Attorney Docket Number	50220

Total Number of Pages in This Submission

ENCLOSURES *(Check all that apply)*

- [ ] Fee Transmittal Form
- [ ] Fee Attached
- [ ] Amendment / Reply
- [ ] After Final
- [ ] Affidavits/declaration(s)
- [ ] Extension of Time Request
- [ ] Express Abandonment Request
- [ ] Information Disclosure Statement
- [ ] Certified Copy of Priority Document(s)
- [ ] Reply to Missing Parts/ Incomplete Application
- [ ] Reply to Missing Parts under 37 CFR 1.52 or 1.53
- [ ] Drawing(s)
- [ ] Licensing-related Papers
- [ ] Petition to Accord a Filing Date
- [ ] Petition to Convert to a Provisional Application
- [ ] Power of Attorney, Revocation Change of Correspondence Address
- [ ] Terminal Disclaimer
- [ ] Request for Refund
- [ ] CD, Number of CD(s) _____
- [ ] Landscape Table on CD
- [ ] After Allowance communication to (TC)
- [ ] Appeal Communication to Board of Appeals and Interferences
- [ ] Appeal Communication to TC (Appeal Notice, Brief, Reply Brief)
- [ ] Proprietary Information
- [ ] Status Letter
- [x] Other Enclosure(s) (please identify below)

Response to Notice of Incomplete Non-Provisional Application

☒ Supplemental declaration
copy of Notice (Tab D)
drawings (Tab E)

Remarks

It is believed that no request for extension of time or fees are due. Notwithstanding, the Commissioner is authorized to charge any additional fees incurred or credit any overage to Deposit Account No.50-1753 (50220). Please regard this as a further request for extension of time to the extent one is needed. (Customer Account Number 22929)

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm Name	Sue Z. Shaper, PC		
Signature			
Printed name	Sue Z. Shaper		
Date	February 17, 2005	Reg. No.	31663

CERTIFICATE OF TRANSMISSION/MAILING

I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service via Express mail #EV671531048 US in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date shown below.

Signature			
Typed or printed name	Sue Z. Shaper	Date	February 17, 2005

This collection of information is required by 37 CFR 1.5. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO/SB/04 (09-04)
Approved for use through 07/31/2006. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

SUPPLEMENTAL DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.67)

Attorney Docket Number	50220
First Named Inventor	Osman
COMPLETE IF KNOWN	
Application Number	10/042,737
Filing Date	8/29/2002
Art Unit	
Examiner Name	

I hereby declare that:

Each inventor's residence, mailing address, and citizenship are as stated below next to their name.

I believe the inventor(s) named below to be the original and first inventor(s) of the subject matter which claimed and for which a patent is sought on the invention entitled:

Square Ultra Thrust Reverser System

(Title of the Invention)

the drawings of which

[X] Are attached hereto (drawings resubmitted)

And

[X] was filed on (MM/DD/YYYY) 08/29/2002 as United States Application Number or PCT International Application Number 10/042,737 and was amended on (MM/DD/YYYY)

I hereby declare that the subject matter of the [X] attached amendment [ ] amendment filed on was part of the invention and was invented before the filing date of the original application, above identified for such invention.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or (f), or 365(b) of any foreign application(s) for patent, inventor's or plant breeder's rights certificate(s), or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent, inventor's or plant breeder's rights certificate(s), or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	NO
			[ ]	[ ]	[ ]
			[ ]	[ ]	[ ]
			[ ]	[ ]	[ ]
			[ ]	[ ]	[ ]

[ ] Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

PTO/SB/14 (09-04)
Approved for use through 07/31/2006. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

SUPPLEMENTAL DECLARATION – UTILITY OR DESIGN PATENT APPLICATION

Direct all correspondence to: [X] The address associated with Customer Number: 22929
OR [ ] Correspondence address below

Name
Sue Z. Shaper

Address
1800 West Loop South, Suite 1450

Address

City	State	ZIP
Houston	Texas	77027

Country	Telephone	Fax
USA	713 550 5710	713 550 5709

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name of Sole or First Inventor: [ ] A petition has been filed for this unsigned inventor

Given Name	Family Name or Surname
Medhat A.	Osman

Inventor's Signature _____ Date 2/16/2005

Residence: City	State	Country	Citizenship
Gilbert	AZ		U.S.

Mailing Address
2316 East Cathy Court

Mailing Address

City	State	ZIP	Country
Gilbert	AZ	85296	

Name of Second Inventor: [ ] A petition has been filed for this unsigned inventor

Given Name	Family Name or Surname

Inventor's Signature _____ Date

Residence: City	State	Country	Citizenship

Mailing Address

Mailing Address

City	State	ZIP	Country

[ ] Additional inventors or a legal representative are being named on the ___ supplemental sheet(s) PTO/SB/02A or 02LR attached hereto.

S:\Documents and Settings\Sue Shaper\My Documents\Shaper\Osman\50220 Supplemental Declaration.doc

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s): Medhat A. Osman	
Application No.: 10/042,737	Art Unit:
Filed: 8/29/2002	Examiner:
Title: Square Ultra Thrust Reverser System	
Attorney Docket No.: 50220	

Office of Initial Patent Exam
Formality Review
Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

RESPONSE TO NOTICE OF INCOMPLETE NONPROVISIONAL APPLICATION MAILED 1/24/05

Dear Sirs:

I offer the attached materials to reconstitute your records, to the extent necessary.

The following is my understanding of events.

- Attorney Jim Farmer, on behalf of inventor Med Osman, filed a petition on 8/29/02 to accord Mr. Osman a filing date under 37 CFR 1.53. A copy of my copy of this document is attached hereto under tab A. On page 3 of the petition Mr. Farmer requested that a copy of the nonprovisional application and revised claim set, submitted with the petition, at least be considered as a new application, filed as of the Express Mail date of the petition, in the event that the Examiner could not accord Mr. Osman the filing date of March 27, 2001, as requested.
- In December, 2004, I was contacted by Mr. Osman to see if I could respond for him to a "Notice to File Missing Parts of Nonprovisional Application," mailed 11/04/2004, copy attached hereto under tab B.

("first notice") (Mr. Farmer is apparently now employed by a corporation.) A filing date of 8/29/02 had been granted.

- My Response, a copy attached hereto as tab C, included a check, certificate of mailing by Express Mail, copy of the Notice to File Missing Parts, permission to charge deposit account for underpayments or credit overpayments, a Declaration and Power of Attorney and a substitute specification. The substitute specification, claims and abstract comprised 17 pages.
- Mr. Farmer received, at the end of January, the attached Notice of Incomplete Non-Provisional Application, mailed 1/24/05, tab D. This "second" notice recites that the application was deposited "without drawings." The "second" notice further recites that the filing date will now be the date of the receipt of the "drawings."
- I had a lengthy phone conversation with a gentlemen in the OIPE, who was quite polite, helpful and sympathetic. Apparently, as best he could tell, the file now lacks any copy of Mr. Farmer's specification or drawings filed 8/29/02 with his petition although it apparently has my newly filed specification and the Declaration/Power of Attorney, (notwithstanding that the above second Notice was yet mailed to Mr. Farmer.)

It is submitted that the evidence indicates that the drawings were attached to Mr. Farmer's petition of August 29, 2002. E.g. (1) My copy of his papers contains 14 drawing sheets. (2) The first notice to file missing parts did not indicate that any drawings were missing. It only indicated that the specification was in the wrong format. A filing date of 8/29/02 was granted.

It is surmised that Mr. Farmer's original specification and drawings were somehow "misplaced" during subsequent "formality review."

Notwithstanding the above, as tab E, Applicant resubmits herewith 14 pages of drawings, comprising a copy of the drawings submitted August 29, 2002, by my records.

Applicant should be accorded a filing date of at least August 29, 2002 since all of the evidence indicates that the drawings were included with the petition of that date which became the "application," as acknowledged by the "first notice."

As indicated on the instant second Notice of Incomplete Non-provisional Application, a petition directed to the attention of the Office of Petitions, accompanied by the $130.00 petition fee, will also be submitted herewith, as well as a request for refund of the petition fee.

Respectfully Submitted,

2/16/5
Date

Sue Z. Shaper
Attorney/Agent for Applicant(s)
Reg. No. 31663

Sue Z. Shaper
1800 West Loop South, Suite1450
Houston, Texas 77027
Tel. 713 550 5710

Jim Farmer
511 E. Concorda
Tempe, AZ 85282
(480) 705-2668 (w)
(480) 894-2517 (h)

September 4, 2002

Med Osman
2316 Cathy Ct.
Gilbert, AZ 85296

Dear Med:

I have enclosed a copy of the petition for the filing date and all the supporting documents, including the new claim set, that were express mailed to the Patent Office on 8/29/02. They now have a complete application on file, and we shouldn't need to do anything further until we receive a response to the petition. At that time we can expect to also receive a Notice of Missing Parts, requiring us to submit a couple of other documents needed for the application (but not for the filing date), such as a Declaration, along with any fees. I would expect them to require the regular application filing fee to be paid, unless in the mean time they find some record of having cashed your previous check.

I will let you know as soon as I receive anything.

Best regards,

Jim

CERTIFICATE OF MAILING BY "EXPRESS MAIL" (37 CFR 1.10) Applicant(s): **Med Osman**			Docket No. **003.0001**
Serial No. **not yet available**	Filing Date **March 21, 2001**	Examiner **Nancy Johnson, Esq.**	Group Art Unit **Office of Petitions**

Invention: **Square Ultra Thrust Reverser**

I hereby certify that the following correspondence:

Petition to accord a filing date under 37 CFR 1.53, and supporting documents

(Identify type of correspondence)

is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 in an envelope addressed to: The Assistant Commissioner for Patents, Washington, D.C. 20231 on

8/29/02
(Date)

James L. Farmer
(Typed or Printed Name of Person Mailing Correspondence)

James L. Farmer
(Signature of Person Mailing Correspondence)

EK738611139US
("Express Mail" Mailing Label Number)

Note: Each paper must have its own certificate of mailing.

TRANSMITTAL LETTER (General - Patent Pending)	Docket No. 003.0001

In Re Application Of: **Medhat A. Osman**

Serial No.	Filing Date	Examiner	Group Art Unit
not yet available	3/27/01	Nancy Johnson, Esq.	Office of Petitions

Title: **Square Ultra Thrust Reverser**

TO THE ASSISTANT COMMISSIONER FOR PATENTS:

Transmitted herewith is:

A petition to accord a filing date under 37 CFR 1.53
Power of Attorney
Copy of Non-provisional patent application originally filed on 3/27/01, and corresponding certified mail receipt.
Copy of Provisional patent application S/N 60/192,337, and filing receipt
Revised claim set for non-provisional application noted above.

in the above identified application.

- ☐ No additional fee is required.
- ☒ A check in the amount of **$130.00** is attached.
- ☐ The Assistant Commissioner is hereby authorized to charge and credit Deposit Account No. as described below. A duplicate copy of this sheet is enclosed.
  - ☐ Charge the amount of
  - ☐ Credit any overpayment.
  - ☐ Charge any additional fee required.

James L. Farmer
Signature

Dated: 8-29-02

James L. Farmer
Reg. No. 42,525
511 E. Concorda Dr.
Tempe, AZ. 85282
(480) 894-2517

I certify that this document and fee is being deposited on 8/29/02 with the U.S. Postal Service as ~~first class~~ Express mail under 37 C.F.R. 1.10 and is addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231. Label # EK738611139 US

James L. Farmer
Signature of Person Mailing Correspondence

James L. Farmer
Typed or Printed Name of Person Mailing Correspondence

cc:

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

POWER OF ATTORNEY

Docket No.
003.0001

Name of Applicant: **Medhat A. Osman**
Address of Applicant: **2316 E. Cathy Court**
Gilbert, Arizona 85296

Title: **SQUARE ULTRA THRUST REVERSER SYSTEM**

Serial No., if Any: **not yet available**
Filed: **3/27/01**

TO THE ASSISTANT COMMISSIONER FOR PATENTS

The Assistant Commissioner for Patents
Washington, D.C. 20231

Honorable Sir:
I hereby appoint:

James L. Farmer
Registration no. 42,525

as principal attorneys to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

Please direct all future correspondence to:

James L. Farmer
511 E. Concorda Dr.
Tempe, AZ 85282
Tel. (480) 894-2517

By: _____
Medhat A. Osman

Dated: 8/20/02

COPY

United States Patent [ ]

[ ] SQUARE ULTRA THRUST REVERSER SYSTEM

[ ] Inventor: Medhat A. Osman, 2316 E. Cathy Court
Gilbert. AZ 85296

[ ] Appl. No.: 60/192,337
[ ] Filed; Mar. 27. 2000

[ ] Int.Cl.
[ ] U.S. Cl.
[ ] Field of Search 244/110 B; 239/265.19. 239/265.24,265.31,265.27

[ ] References Cited
U.S. PATENT DOCUMENTS

Re. 24,703	9/1959	Brame .
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3,013,751	12/1961	Scott et al.. .
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3,610,534	10/1971	Medawar et al. .
3,612,400	10/1971	Johnson et al..
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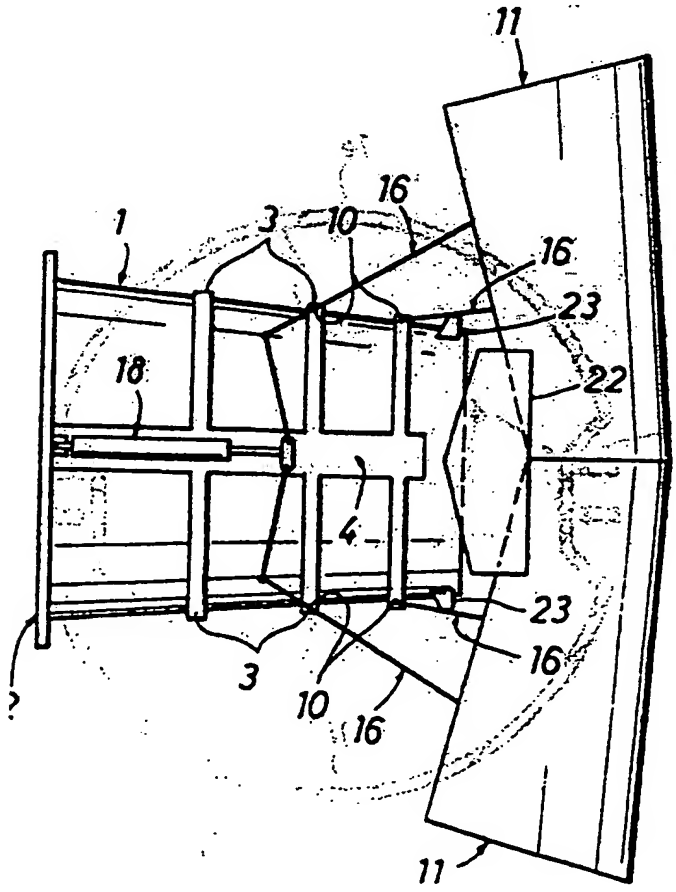
4,865,256	9/1989	Durand et al. .
5,056,828	10/1991	Pillari ..... 244/110 B
5,058,828	10/1991	Pillari .
5,176,340	1/1993	Lair ..... 244/110 B
5,243,817	9/1993	Matthias .
5,284,015	2/1994	Carimali et al. .

Primary Examiner—
Attorney, *Agent, or Firm*—

[ ] ABSTRACT

A thrust reverser system for jet engine comprising a tailpipe, Square/trapezoidal clamshell doors and actuators, wherein the tailpipe and clamshell doors may be corrugated, the corrugations can be mating, the actuators may be situated out of the external free air flow, the doors may be stowed out of contact with internal engine gas flow and that may include a tail pipe aft fairing having a movable section .

2 Claims, 14 Drawing Sheets



SQUARE ULTRA THRUST REVERSER SYSTEM

FIELD OF INVENTION

This invention relates to thrust reverser systems for aircraft jet engines, based on the ULTRA THRUST REVERSER SYSTEM U.S. Patent 5,615,834. This patent relates to Applicant's Disclosure Document filed March 27, 2000, application number 60/192,337. Thrust reverser systems are used to decelerate a jet aircraft, and in particular to slow it down after landing, to slow it down during taxiing, and to aid it to back-up from a tight spot or a gate if needed. Reversing the exhaust jet flow from the engines provides the desired deceleration, especially on short runways, and slows down the aircraft to a safe taxiing speed thereby allowing the pilot to use the brakes on the taxiways.

Previous designs such as U.S. Pat. Nos. 2,968,150 and 3,610,534, sometimes referred to as four bar designs, the thrust reverser is built around the exhaust tailpipe. However, the protrusion of the actuation mechanism into the free air stream surrounding the reverser system, or engine nacelle, has the disadvantage of possibly incurring significant external drag which can penalize aircraft performance in various modes of operation and higher weight penalty.

U.S. Pat. No. 4,129,269, referred to in the industry as the single-pivot design, provides a light construction thrust reverser concept in which the movable doors and a reduced tailpipe form the exhaust system in forward thrust. The single-pivot design has the disadvantage of possibly permitting leakage of the internal engine gas flow between the stowed doors and the tailpipe. Exhaust flow leakage through the door/tailpipe system, do adversely impact engine thrust performance, fuel consumption and overall aircraft performance.

The ULTRA THRUST REVERSER SYSTEM is built on a continuous tailpipe to minimize external drag, while avoiding the drawbacks of leakage from the exhaust tailpipe. Exhaust plumes from both of the aforementioned conventional reverser designs are known to sometimes affect the aircraft control surfaces during reverse thrust operation. Both aforementioned designs therefore can require additional external surfaces to be attached to the aircraft pylon or other methods to divert the plume away from such control surfaces. Those additional external surfaces, mandated by considerations of compatibility and systems integration of the reverser with the aircraft, add further cost, weight, potential drag and vibration.

The new SQUARE ULTRA THRUST REVERSER SYSTEM design of the present invention optimizes primarily reverse thrust performance by re-designing the shape of the inner door surface to make it flat compared to the existing circular configurations, to maximize the efficiency of reverse flow in the forward direction and to reduce the likelihood of exhaust plume impingement on the aircraft surfaces. In the forward thrust mode, the SQUARE ULTRA is similar to the ULTRA THRUST REVERSER SYSTEM, in the fact that it comprises the design features which optimize forward thrust performance during the various modes of forward flight, and especially during the cruise mode where the aircraft spends most of its flight time. The new design preserves the prior design features in the same manner by combining lighter construction with the primary goal of optimizing internal and external flow aerodynamic characteristics. The rectangular/trapezoidal door design deals effectively with aircraft/thrust reverser integration and compatibility issues, primarily the plume impingement on the aircraft control surfaces, discussed above, by using the sides of the rectangular doors as a buffer to prevent exhaust gases from escaping laterally and impinging on the aircraft surfaces, thereby providing an integrated means to control the plume and divert it away from the aircraft control surfaces. The reverse thrust efficiency is increased by using flat surfaces in the door design to deflect the majority of exhaust gases forward. The new design combines all the characteristics of the ULTRA THRUST REVERSER SYSTEM in addition to better reverse flow performance.

The housing design, in general, for the reverser system, including the actuators and the associated operating mechanism, can adversely affect the external air flow around the tailpipe causing external drag (due to the protrusion of reverser mechanisms in the free air stream around the nacelle thereby causing excessive drag during flight as in the case of the conventional four bar design. The housing design disclosed herein is based on the ULTRA REVERSER design, wherein it benefits from the fact that its housing not only affords no leakage path in the internal gas flow, but also that its housing does not protrude into the free air stream around the nacelle. Conventional single pivot reverser designs have the potential for significant flow leakage between such doors and the rest of the tailpipe. This defect is compounded by a further inability of that design to control the tailpipe exit area which adversely affects forward thrust. These two defects of this particular conventional housing design severely affect the engine's fuel consumption and performance, penalizing the aircraft's overall performance and range. On the other hand, excessive drag during flight incurred by the other conventional four bar housing design also penalizes the aircraft's overall performance and range. This drag is eliminated by using the housing design approach used on the ULTRA REVERSERSYSTEM.

Conventional construction techniques for target type thrust reverser components, single pivot or four bar, rely heavily on riveting together individual details and subassemblies of hardware, such as frames, inner skin, outer skin and other detail parts, A multitude of pieces of hardware and the extensive use of riveting increases the system weight as well as development, tooling and

manufacturing costs. These aspects of design are adversely reflected in the aircraft's gross weight, payload, performance and cost of operation. The present invention is based on the lighter construction approach disclosed on the ULTRA REVERSER SYSTEM, including an integral exhaust tailpipe and integral rectangular/trapezoidal clamshell door construction, actuators and control systems. Integral construction of the tailpipe and doors provide a lighter, stronger structural system compared to conventional construction methods which are heavier, and labor intensive. The new system requires less investment in tooling. The incorporation of the side fairings into the rectangular/trapezoidal doors of the new design improves aerodynamic performance by providing blockage for plumes to prevent escaping and impingement on the aircraft fuselage and/or control surfaces, reduces gaps, and contributes to the reduction of external drag characteristics for better fuel consumption and enhances the overall aircraft/engine performance. The new SQUARE ULTRA design, like the ULTRA THRUST REVERSER SYSTEM uses two actuators to deploy the doors or in other configuration where four actuators are used to deploy the doors.

SUMMARY OF THE INVENTION

The invention comprises a rectangular/trapezoidal target doors for a thrust reverser system for jet engines. The rectangular/trapezoidal doors provide a relatively flat surface configuration facing the incoming exhaust gases, which in turn help deflect the exhaust gases forward in a more uniform fashion, thereby reducing the possibility of deflection of exhaust gases laterally thereby resulting in some of the exhaust gases/plumes impinging on the aircraft surfaces.

The side surfaces of the rectangular/trapezoidal doors, act as a strong buffer blocking lateral plumes, thereby minimizing the possibility of impingement on the aircraft surfaces and keeping the majority of the reverse exhaust flow contained by the doors to exert forward decelerating action.

With the rectangular/trapezoidal door shapes, a new actuation system configuration is used in the SQUARE ULTRA REVERSER SYSTEM where in an alternate configuration each door is driven by two actuators mounted directly between the tailpipe and the doors providing direct motive force to deploy the doors eliminating the driver link mechanism used in the ULTRA THRUST REVERSER SYSTEM. Therefore the SQUARE ULTRA REVERSER SYSTEM can be designed with either actuation/door deployment arrangement.

The reverser system includes a tailpipe, attached clamshell doors and actuators, including linkage, for moving the doors. The actuators and linkage attach between the tailpipe and the doors and move the doors between a stowed position, out of contact with the internal engine gas flow, to a deployed position, diverting internal engine gas flow aft of the tailpipe.
In the preferred embodiments the actuators are housed together with the tailpipe and doors, either on the sides in an internal blister or in the door corners, to form a protrusion free surface for external free air flow over the thrust reverser system area or nacelle similar to the ULTRA THRUST REVERSER SYSTEM.

The actuators may be connected to a pressure booster system to minimize their size. In preferred embodiments the tailpipe comprises a corrugated body. These body corrugations include annularly structured ridges or hats and axially structured depressions or blisters formed with on or in the tailpipe skin. Preferably, the actuators attach to the tail pipe so as to be located in the axial body depressions, and portions of the actuator linkage attach to annular ridge corrugations of the tailpipe body. Acoustical material may be attached over the surface of the tailpipe. In other configuration, four actuators, one at each corner of the door, are used to drive the target doors, thereby eliminating the need for axial body depressions in the tailpipe and eliminating a portion of the actuation linkages.
In preferred embodiments the clamshell doors also have a corrugated body, comprising a smooth outer skin bonded to a corrugated inner skin, In the preferred embodiments the clamshell doors form a pair of semi-rectangular/trapezoidal doors.
One door, in addition, may include a body extension, or fairing, in the side direction. Such a door body extension would underlie a portion of the second door in the stowed position. The thrust reverser system may include an aft fairing attached to the tailpipe, a portion of which may be movable from a stowed position out of contact with the flow of the internal engine gas to a deployed position extending rearward of the tailpipe to further guide internal engine gas flow aft of the tailpipe. Preferably, the movable portion of the aft fairing would comprise two sections. Actuators or motors could move these movable portions.

BRIEF DESCRIPTION OF THE DRAWINGS

A better understanding of the present invention can be obtained from the detailed description of exemplary embodiments set forth below, to be considered in conjunction with the attached drawings, in which;

FIGS. 1 and 2 illustrate, by side plan and cross section views, respectively, an integral, tailpipe construction, wherein three integral annular corrugated hat or rib sections, for the purpose of discussion, are shown as providing structural integrity, and one axial depression is indicated with attachment points for the actuators.
FIGS. 3 and 6 illustrate, by side plan view and cross section, a tailpipe design (with stowed rectangular/trapezoidal doors indicated in dashed line in the former), the design making provision for an acoustic treatment of the tailpipe.
FIG. 4 illustrates by detail drawing an option of covering an interior base of a corrugated hat section of the tailpipe (or the door) with a strip of material.

FIGS. 7,3b and 10 illustrate side plan and detail views, respectively, of a tailpipe including cross section details of an attachment point for connecting a link to the tailpipe.

FIGS. 5, 8 and 9 illustrate an end view of the tailpipe, forward looking aft, indicating the axial depressions that form the internal blisters to house the actuators, as well as details of the actuator forward mounts on both sides of the tailpipe flange, respectively,

FIG. 11 illustrates in perspective a tailpipe.

FIG. 12 illustrates a side plan view of the upper and lower doors over the tailpipe, which doors constitute the outer surface of the nacelle surface in the stowed position, with the deployed position indicated in dashed lines, and including aft fairing for the tailpipe; FIG. 12 also indicates the corrugating mating door integral hat sections with an integral end kicker plate arrangement as well as integral door frames inner skin,

FIG. 13 illustrates in plan view the doors overlying the tailpipe and fixed and moveable aft fairings, with an indication of the internal blisters that house the actuators.

FIGS. 14 A & B illustrate an end view of the doors over the tailpipe, forward looking aft into the tailpipe, indicating in particular a cavity formed between the door edges over the tailpipe internal blisters for housing an actuator on each side of the tailpipe. The upper door is rectangular while the lower door is shown as trapezoidal, which is the alternate configuration for the door invention. In FIG.14 B the tailpipe does not have an internal blister since the door is deployed using four actuators located at the corners of the doors.

FIG. 15 illustrates in end view a door indicating attachment points for the links and a side fairing combined with the door skin.

FIGS. 16 and 17 illustrate details of the attachment point.

FIG. 18 illustrates in side plan view the inner skin of the door, showing the integral frame sections, the end plate, the attachment fittings and indicating the underlap feature.

FIG. 19 illustrates a door inner and outer skin in perspective showing the Square design shape to improve the containment of the exhaust plumes using the straight surfaces forming the sides of the doors, versus the circular door shapes used in the aforementioned patents.

FIGS. 20 and 21 show cross-sections of a door and tailpipe, not at a hat or rib and at a hat or rib, respectively, illustrating the integral fairings arrangement, the underlap extension concept, the actuators position and the internal tailpipe blisters.

FIG. 20 shows a trapezoidal door configuration while FIG. 21 shows a rectangular door configuration which both fall under the SQUARE ULTRA REVERSER design concept.

FIGS. 22, 23 and 24 illustrate the actuator system, its attachment to the tailpipe and an actuator piston anti-rotation arrangement.

FIG. 25 illustrates a hydraulic system with an intensifier for supplying high pressure hydraulic fluid to the actuators for each thrust reverser, the illustration assumes a two engine configuration, with two actuators per engine for simplicity though other configuration for same patent uses four actuators per engine. Each actuator having two ports, one for deployment and the other for stow operations, and where hydraulic and electric controls for sequence of deployment and restow have been simplified, for discussion purposes, since they are similar to current practices mandated by the airworthiness regulations for safe operation of thrust reverser systems.

FIGS. 26 and 27 illustrate the reverser system in deployment position with the general arrangement of the actuator, the connecting links, the fixed and movable fairings and the tailpipe, a side view and an end view, forward looking aft.

FIG. 28 shows the general arrangement of the actuation system, links and hydraulic actuator with the doors represented in dashed lines. The arrows show the direction of rotation and translation of the doors. Stow is in reverse direction.

FIG. 29 shows the motion of the driver link, which is connected to the actuator, to the deploy position. Stow is in reverse direction.

FIG. 30 shows a cross-section of the pivoting point design showing the pivoting axis, the supporting bearing and packing arrangement housed in one of the tailpipe hat sections and attached to a door link.

FIG. 31 shows an isometric view and a side view for the rectangular/trapezoidal doors in the deploy position for the configuration where four actuators are directly connected to the doors replacing the driver link and the tailpipe does not have an internal blister.

FIG. 32 shows a comparison of the impact of the rectangular/trapezoidal flat surface in allowing the majority of the exhaust gases to rebound in the forward direction, as compared with the circular door shape in which exhaust gases bounce back in different directions thereby reducing reverse thrust efficiency and can be conducive to exhaust plume escape and impingement on aircraft surfaces

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

The design concepts included in preferred embodiments of the thrust reverser system include an integrally constructed exhaust tailpipe best illustrated in FIG.1E. The integrally constructed corrugated exhaust tailpipe 1 acts as the main structure carrying the various thrust reverser system components and loads. The thrust reverser loads (in the reverse mode) are transmitted through the tailpipe 1 to the engine bulkhead (not shown), to be bolted to a tailpipe attachment flange 2.

As illustrated in FIGS. 1-11, the integral corrugation construction of tailpipe 1 includes hats or ridges 3, which comprise annular corrugations sometimes referred to as ribs, which can be pressed into the tailpipe material or attached externally to the tailpipe skin, and internal axial blisters or depressions 4, located on each side of tailpipe 1. This integral corrugated design form a cage structure that permits

the tailpipe itself to transmit reverse thrust loads directly, in lieu of requiring separate frames to be riveted to the tailpipe skin. The integral ridges and blisters form a cage-like frame upon the skin of the tailpipe itself. This integral construction technique significantly reduces the manufacturing time and cost and results in a lighter and stronger tailpipe. The hat or rib sections 3 act as the traditional Z or L-sections, by providing twice as much rigidity as traditional Z or L-sections without incurring the weight penalty. If acoustic attenuation is needed, as illustrated in the preferred embodiment in FIG. 3, especially for turbojet or low bypass applications, a similar tailpipe design can be utilized where a bonded honeycomb 5, or whatever sound attenuation material is desired, can be sandwiched between a smooth tailpipe outer skin 6 and an inner corrugated
tailpipe perforated skin 7, having an inside surface 7*i* and an outside surface 7*e*. Skin 7 maintains the integrally constructed corrugated tailpipe structure of the tailpipe of FIG.1. Skins 6 and 7 and the sound attenuation material 5 are to be sandwiched and attached together using an appropriate attachment process, depending on the materials used for construction. The hat section areas 3 of skin 7 and the axial depressions 4, would not have any perforations 7A, to enhance structural integrity. Other configurations could be made where the corrugations could be in the outer skin 6 which is attached or fastened to the inner skin 7, enclosing the sound attenuation material between them as before.
A strip of material 8, or any other compatible material depending on the material used for construction, could be attached to the inside surface 1*i* of tailpipe 1, under hat sections 3, in areas exposed to internal flow to enhance internal gas flow characteristics and increase rigidity, if needed. See FIG. 5. The tailpipe surface in the internal gas flow path area will be generally smooth and continuous, except for the base areas of hat sections 3, which are essentially insignificant. Importantly, the contact surface for the internal gas flow through the reverse thrust system is comprised of the unitary tailpipe 1 itself and thus does not allow for any leakage or interruption of the exhaust gas flow, which in turn requires elaborate sealing designs and still results in exhaust flow leakage of several percent with time and stack-up of hardware tolerances. This gas flow leakage from the tailpipe is a major contributor to the deterioration of the overall aircraft/engine system performance, reflected in an increase in fuel consumption and a decrease in range.
Tailpipe attachment flange 2, FIG. 1, includes attachment points 9 for the actuators 18. FIG. 7 illustrates in plan view tailpipe 1 wherein the actuator link assembly pivots at point 10 located on the tailpipe integral frame hat section 3. Four link attachment pivot points 10 on the tailpipe are shown. These pivot points connect the doors to the tail pipe frame through links or connecting rods 16.

Another arrangement whereby the tailpipe 1 has no axial internal blister where the actuators 18 are attached to the tailpipe as shown in FIG. 31. In this arrangement each one of the actuators 18 substitutes one of the link assemblies 16 and the actuator itself is used to directly deploy/stow the target doors.
Pivot point 10 is more clearly illustrated in detail in FIGS. 30 and 10. Connecting link 16 attaches to pivot 29 having cylindrical housing 30 for bearing 26, and including packing 27. Housing assembly 10 attaches to hat section 3 by attachment means 28.
FIG. 9 shows an end view of tailpipe 1, forward looking aft through the tail pipe. Attachment flange 2 having actuator attachment points 9 is illustrated and more particularly detailed in FIGS. 8 and 5.
FIGS. 12-19 and FIGS. 20 and 21 illustrate a preferred embodiment for the integral construction of rectangular/trapezoidal clamshell doors 11. The doors consist of rectangular/trapezoidal outer skin 12 and inner skin 13 that can withstand heat. The inner skin 13 preferably has integral frame corrugations 14, comprising two, three or more circular ribs or hats, depending on the loads and the door size. Such design replaces the conventional separate frame construction where structural support usually is riveted between outer and inner skins. The elimination of the conventional frame support results in the elimination of more than half the number of rivets. The present design teaches the direct attachment of the inner skin 13 and outer skin 12, such as at the trough of the hat sections 14, using appropriate attachment and bonding processes. This reduces weight and manufacturing costs significantly. Again, a strip of material could be attached to the base of the annular channel 14 sections on the interior of the doors, or the hat sections 14 can be attached to the inner skin outer surface using appropriate attachment and bonding process, similar to that disclosed in a preferred design. Inner skin 13 includes a kicker end plate 15, located at the forward end of each door (when stowed), to further divert the reversed flow of gases in the reverse mode. Four connecting rods, or links, 16 connect each door 11 to actuators 18 and tailpipe 1, illustrated in FIG. 26. The links are shown connected to the doors using four fittings 24 bolted to portions of the inner door skin 13, as shown more particularly in FIG. 16 and 17. Illustrated in FIG. 15,18 and 19 is the elimination of conventional fairings on the sides of the thrust reverser doors and incorporating those fairings into the integral construction of the doors 11, as done with the circular ULTRA REVERSER SYSTEM. The fact that the doors in the SQUARE ULTRA design have a flat surface for the exhaust flow from the tailpipe to bounce on, this inner skin door configuration helps the majority of the reverse flow to deflect forward in the same general plane as the incoming flow and the same direction of motion of the aircraft, as shown in FIG. 32. The inner skin of circular doors due to the curvature of the surface, causes the reverse flow to bounce in different directions which is conducive to lateral exhaust plumes impinging on the aircraft surfaces and not necessarily contributing to the primary function of reversing the flow to decelerate the aircraft. The two flat sides of the door act as a

buffer to minimize exhaust plume escape in the lateral direction and impingement on the aircraft. Current designs use different shapes of fairings to cover the actuators and actuation mechanism on the side of the tailpipe, in addition provide for the protrusion of the fairings into the free air stream. The elimination of separate individual fairings is achieved by extending the upper and lower doors outer and inner skins, referred to in combination as element **17**, to form rectangular/trapezoidal doors to cover actuators **18**, as shown also in FIGS. **20** and **21**. An important further benefit of this idea is providing extensions **17** on the doors as an additional barrier between the reversed internal engine gases and the aircraft surface to control and contain the reverse flow plume and keep it away from aircraft surfaces. This will also help keep the flow attached to the doors for an extended period of time in the deployed position to further guide the flow forward to achieve the desired reverse thrust. This approach eliminates the cost of the fabrication and tooling of the conventional fairings and decreases gaps between doors and fairings significantly, which gaps have the potential to cause aerodynamic losses. The incorporation of the conventional fairings into the door construction also saves the weight and cost of the fairings attachment to the structure.

In the preferred embodiment in FIGS. **15, 18, 19, 20** and **21** is extension **19** of the inboard and/or outboard side of either an upper and/or lower door. Such extension **19** would be used, as systems integration and compatibility demands, to further divert the exhaust plume in reverse away from the aircraft surface to enhance its stability on the ground during reverse thrust operation. The extension **19** is shown designed to underlap the edge of the other door in the stowed position, FIGS. **20** and **21**, adjacent the actuators **18** received in the tailpipe **1** blisters **4**.

As in the ULTRA REVERSER SYSTEM, the SQUARE ULTRA can use a pressure booster **20** for the reverser actuators **18**, schematically shown in FIGS. **22** and **25**. Customarily hydraulic or pneumatic pressures are used to actuate thrust reverser systems. The idea of boosting pressure could be applied to any type of working fluid. For discussion purposes, the case of hydraulic fluid is used. A hydraulic pressure booster **20** could be installed internally in any section of the aircraft to increase the hydraulic pressure from the aircraft supply, which is usually at 1500-3000 psi. The hydraulic pressure supply to the thrust reverser actuators can be boosted up to 8000 psi or beyond as the technology advances and as sealing technology permits, to meet the most critical reverser need which is usually a restow due to an inadvertent deployment during flight, or as specified by the design or certification requirements. As certification requirements become more stringent and require the ability to restow at increasingly higher speeds, the actuators will tend to become bigger and take more space in the nacelle. This booster approach reduces the necessary size of the hydraulic actuators to be located in the blisters **4** on each side of the tailpipe, which in turn allows each actuator to be housed in a smaller internal tailpipe blister **4** area, thereby minimizing impact on the internal gas flow, or the corner of the door as in the alternate configuration shown in FIG. **31**, thereby avoiding protrusion in the free stream. This approach contributes to the optimization of the overall aerodynamic performance of the thrust reverser system due to the significant reduction of various types of drag (friction, base drag, interference drag). Another benefit of using a hydraulic pressure booster is the ability to maintain commonality of actuator sizes, regardless of the aircraft hydraulic pressure supply, while compensating for the aircraft hydraulic pressure supply in the booster design. This system allows using the same reverser and actuators for several aircraft applications in which each aircraft may have a different hydraulic pressure supply rating, hence allowing the same design to lend itself to multiple applications. The booster will be sized to meet the specific restow requirements which are primarily a function of the doors area and loads.

The SQUARE ULTRA design utilizes the same idea of the ULTRA REVERSER SYSTEM, illustrated in FIGS. **12** and **26**, which is the sliding rearward of a portion **22** of an aft fairing attached to tailpipe **1**, preferably movable portion located on each side of the tailpipe. The driving force may either be through mechanical linkages, or actuated electrically, pneumatically or hydraulically during a deployment cycle. The remainder immobile portion **23** of the aft fairing would be attached to the tailpipe to maintain the external contour line during forward flight mode. Movable aft fairings, **22** as a tail pipe extension, may be spring loaded to keep them retracted during forward thrust and to maintain the external contour lines. The movable aft fairings **22** would move rearward, when needed, to close the small gap between the tailpipe exit plume and the clamshell doors in the deployed, reverse thrust position. This feature keeps the reverse flow enclosed between the deployed doors and the tailpipe to direct the reverse flow along the door's inner walls and forward to achieve the desired reverse thrust and deceleration. The fairings **22** would be in contact with the relatively cooler and higher pressure by-pass flow; therefore, they could be made out of aluminum, for example.

A pocket of extremely high turbulence flow is generated in the vicinity where both doors meet at the end of the deployment stroke for target type reversers. The turbulence is the result of the interaction between the hot gases flowing from the tailpipe rearward and the reverse flow gases rebounding from the inner doors surface. Another benefit of a movable aft fairing portion **22** is using it for alleviation and control of the effect of this highly turbulent flow by controlling the gap between the sliding aft fairing and the doors. It could be set, during flow test, to allow some of the highly turbulent gases to escape to improve the flow characteristics of the rest of the gases along the doors to provide the reverse flow action. The released gases are insignificant, but could have a favorable impact on reverse thrust performance and efficiency. Reverse

thrust efficiency translates into less power from the engine during reverse thrust mode, which can lead to a reduction in the engines' cycle count, extension of the time between engine overhauls and extension of engine components service life due to reduction in accrued operating cycles. The gases would not be allowed to impinge on any of the aircraft control surfaces or critical areas.

In operation, the reverse thrust action aims at slowing down the aircraft after landing or is used for backing up and braking action during taxiing operations. When reverse thrust is commanded, the clamshell doors 11 will be pushed rearward by the actuators, or through a connecting linking mechanism, to a position aft of the exhaust tailpipe exit area to divert the exhaust flow of the engine forward to slow down the aircraft from its landing speed, down to a manageable taxiing speed.

In the preferred design, the force resulting from the exhaust flow impingement on the doors will be absorbed by either the links or the actuators, which in turn transfer the loads onto the tailpipe integral frames, skin and blister structure, which transfer the load to the engine or nacelle bulkhead through a bolted flange.

Boosted hydraulic pressure supply to the thrust reverser actuators would result in the reduction of their respective diameters, thereby minimizing the impact of the tailpipe internal blister housing the actuator system on the internal engine exhaust gas flow path. Even with conventional designs, smaller actuators would help eliminate the need for external blisters protruding in the free air stream. Fairing protrusion in the free air stream to cover the actuation system results in external drag increase leading to a several percent increase in SFC during normal cruise.

The elimination of the separate side fairings achieved by extending the doors to cover the actuation system, as used in the ULTRA THRUST REVERSER DESIGN, also helps effectively enclose the jet flow within the door during reverse mode and prevent it from escaping towards aircraft control surfaces, due to having straight side surfaces for the door instead of circular one as used in other designs. The elimination of the separate side fairings also helps eliminate any need to have external provisions in the free stream to divert any escaped plume away from the aircraft control surfaces.

The foregoing disclosure and description of the invention are illustrative and explanatory thereof, and various changes in the size, shape, and materials, as well as in the details of the illustrated system may be made without departing from the spirit of the invention.

What is claimed is:

1. A rectangular/trapezoidal shaped clamshell doors which maximizes the efficiency of the exhaust flow reversal in the forward direction due to the impingement of the exhaust gases on the flat side of the door, facing the tailpipe exit plane. Circular door designs cause the exhaust flow to rebound in different directions, thereby reducing reverse flow efficiency and can be conducive to the generation of lateral exhaust plumes impinging on the aircraft fuselage or control surfaces creating damage and compromising aircraft control.
2. Actuation system in the rectangular/trapezoidal door design can be either through a linkage mechanism where the actuator is lodged in an axial depression in the tailpipe and driving the doors through mechanical linkages, or attaching the actuators directly between the tailpipe and the rectangular/trapezoidal doors whereby it will directly deploy/stow the doors thereby eliminating a portion of the actuation linkage .

* * * * *

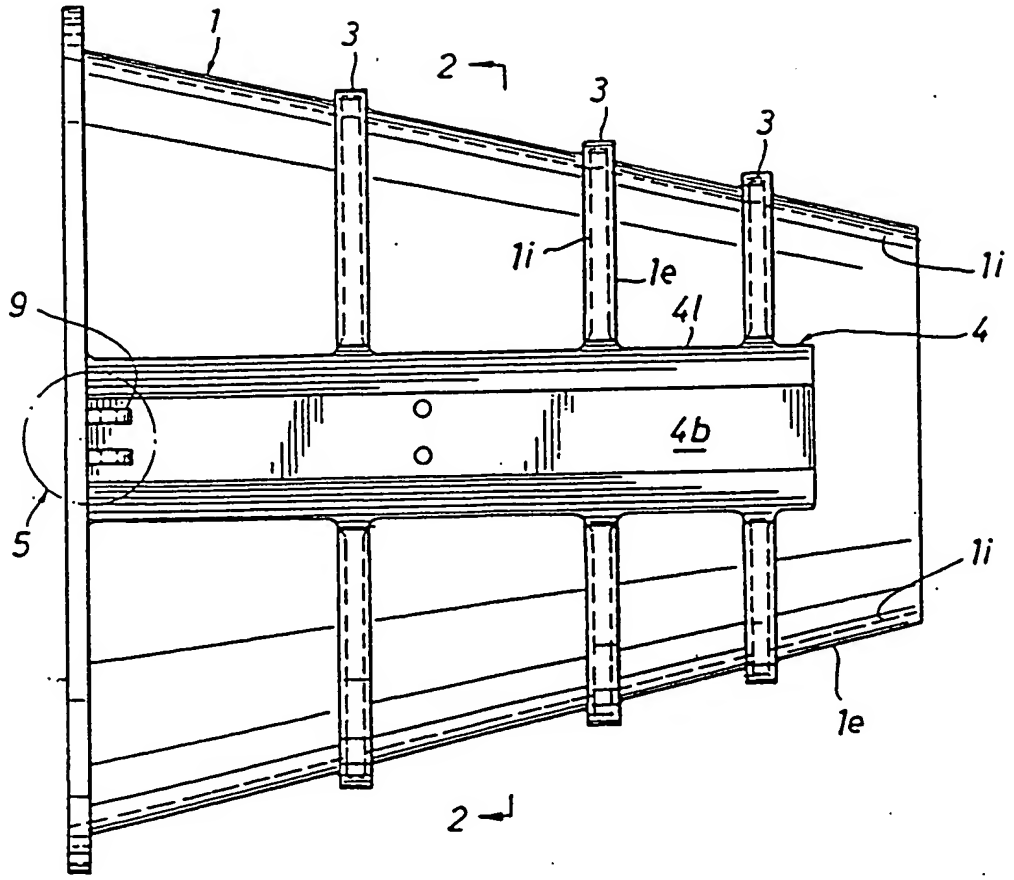


FIG. 1

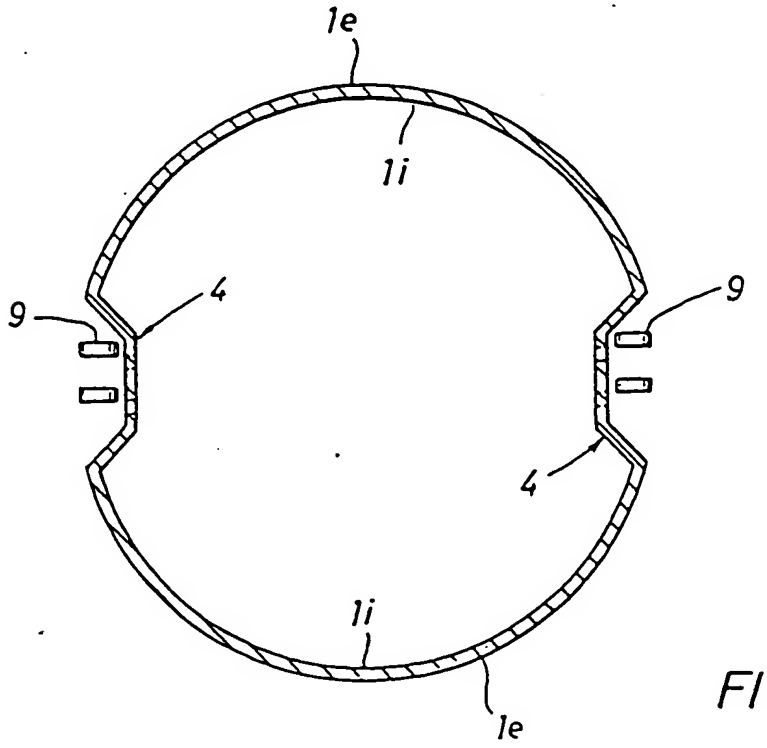


FIG. 2

FIG. 3

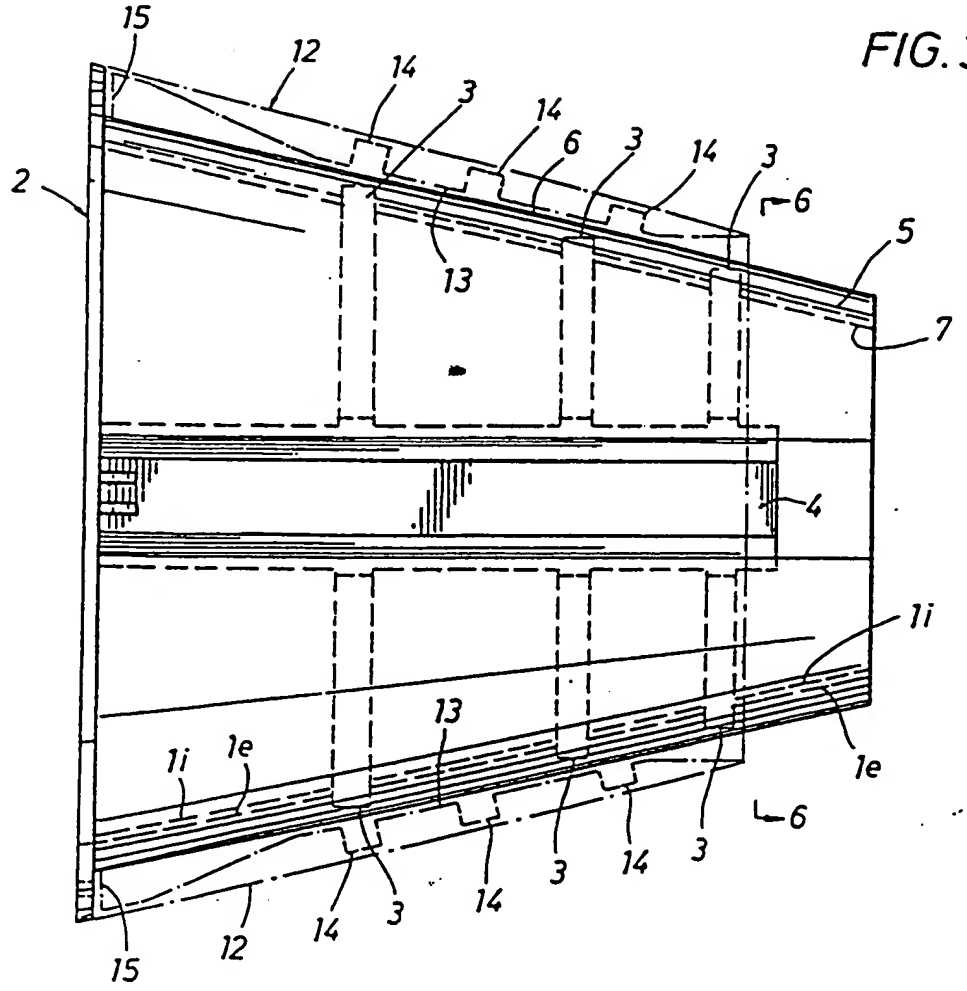
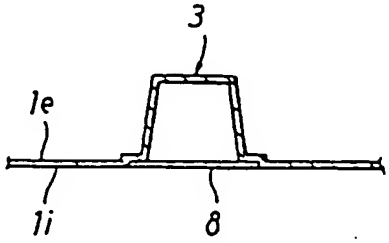


FIG. 4



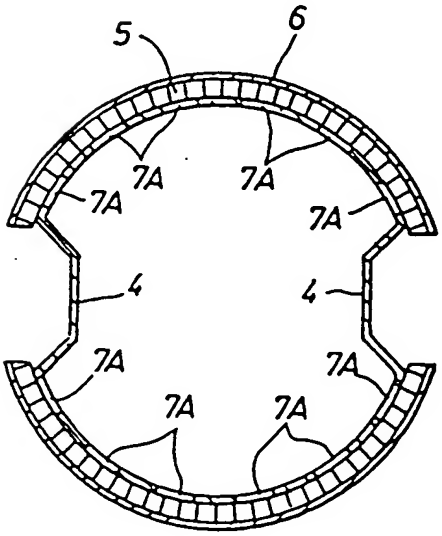


FIG. 6

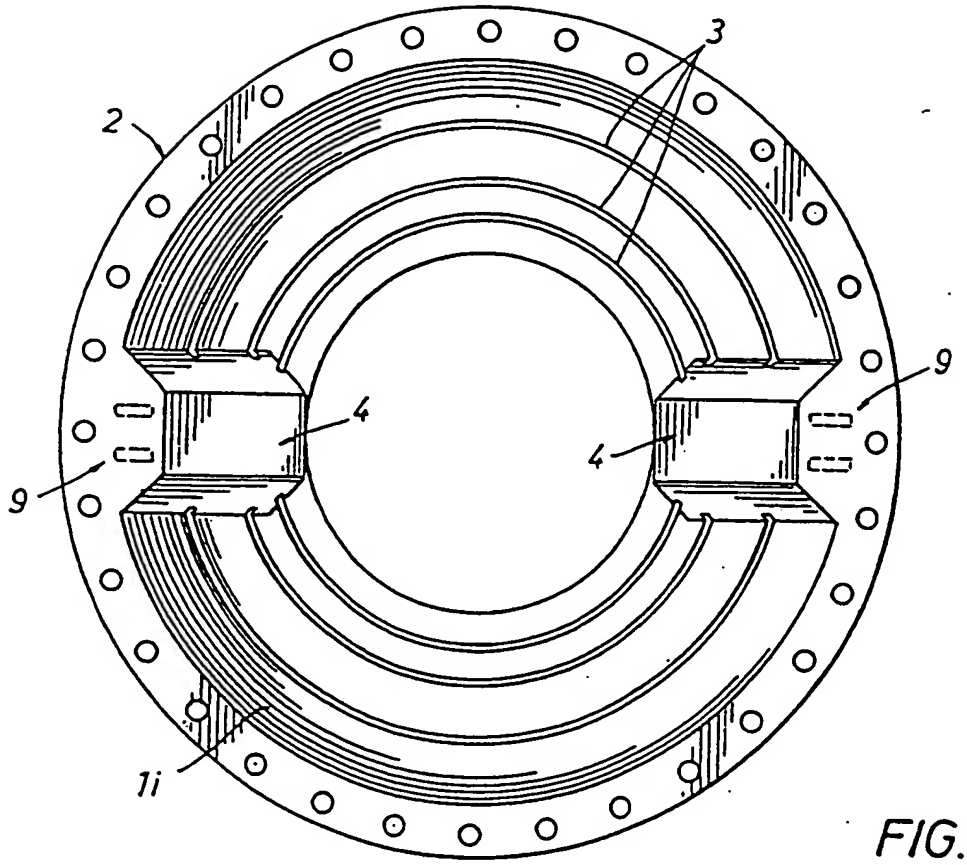
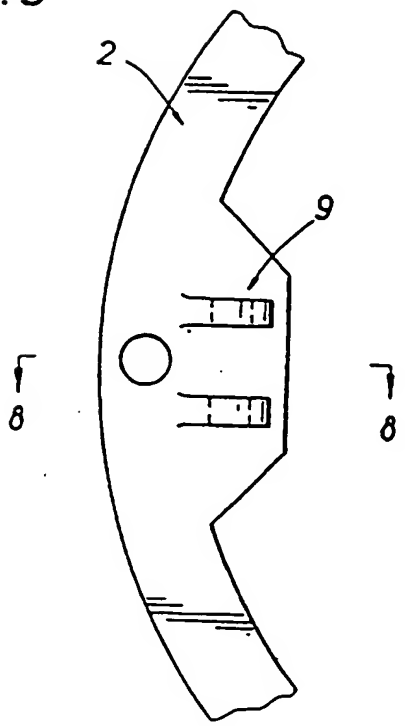


FIG. 9

FIG. 5



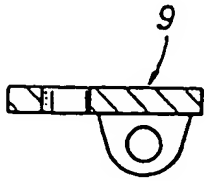


FIG. 8

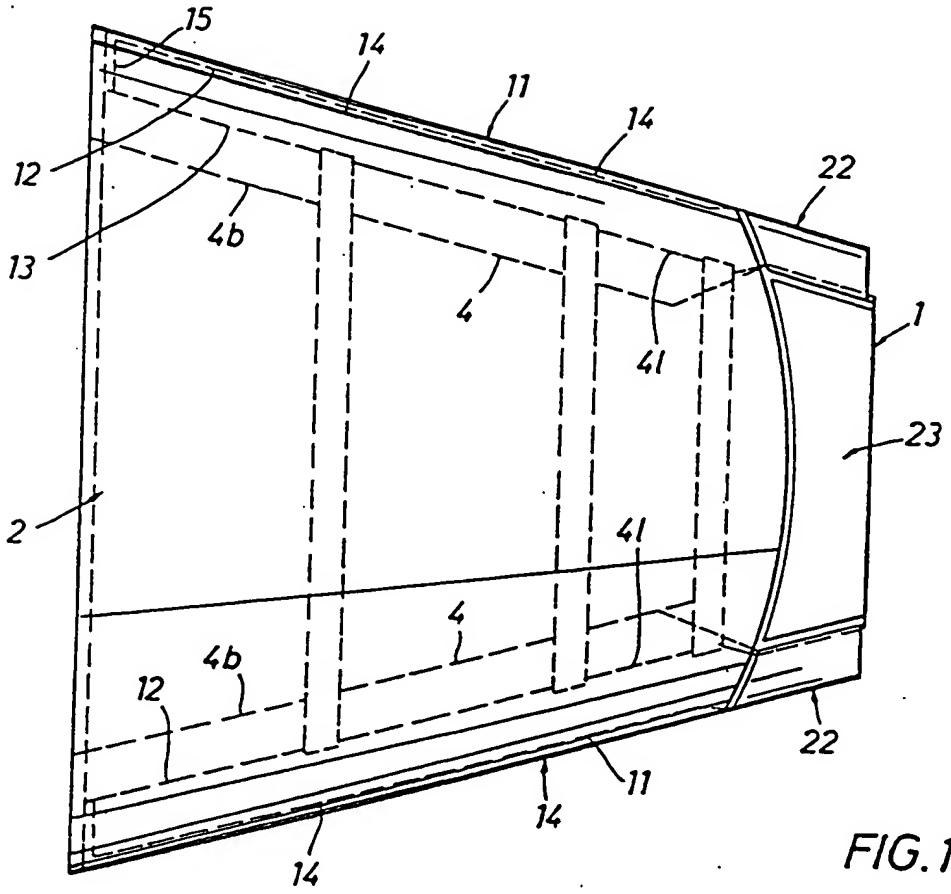


FIG. 13

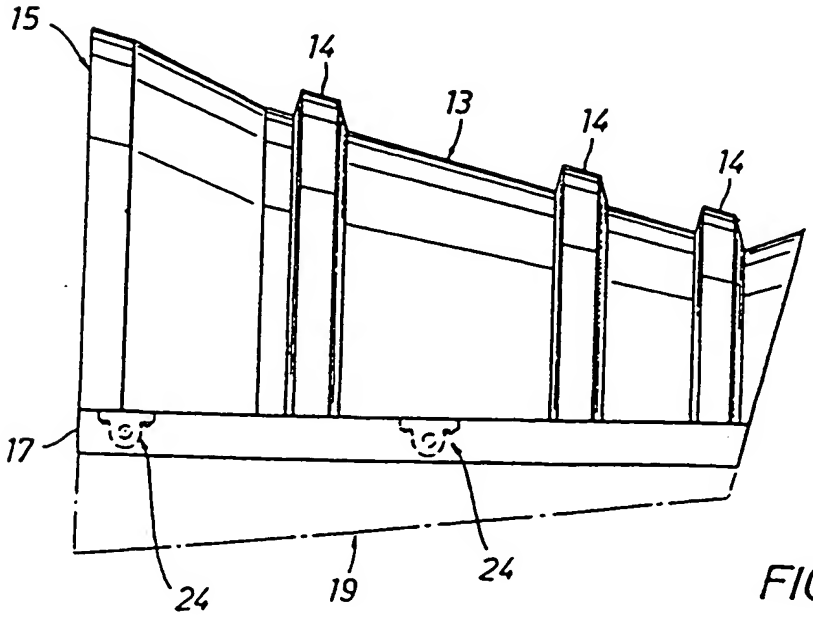


FIG. 18

FIG. 7

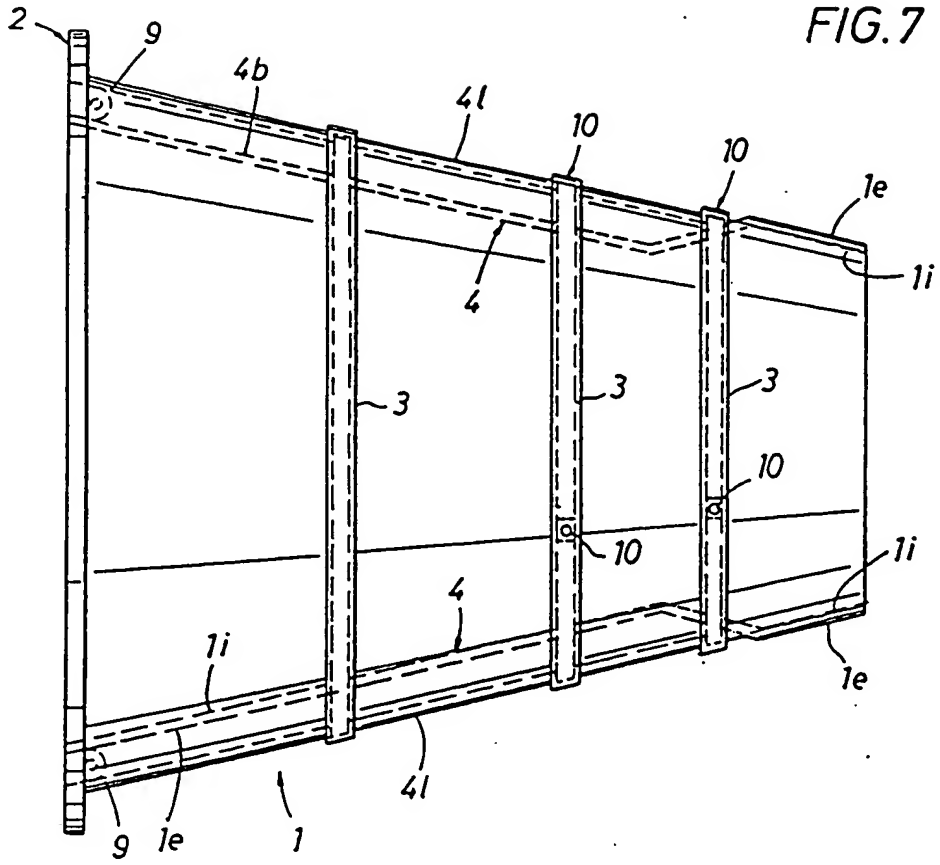
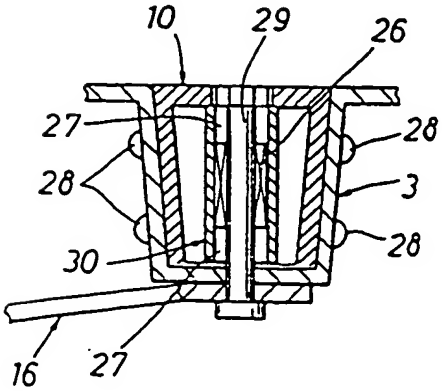


FIG. 30



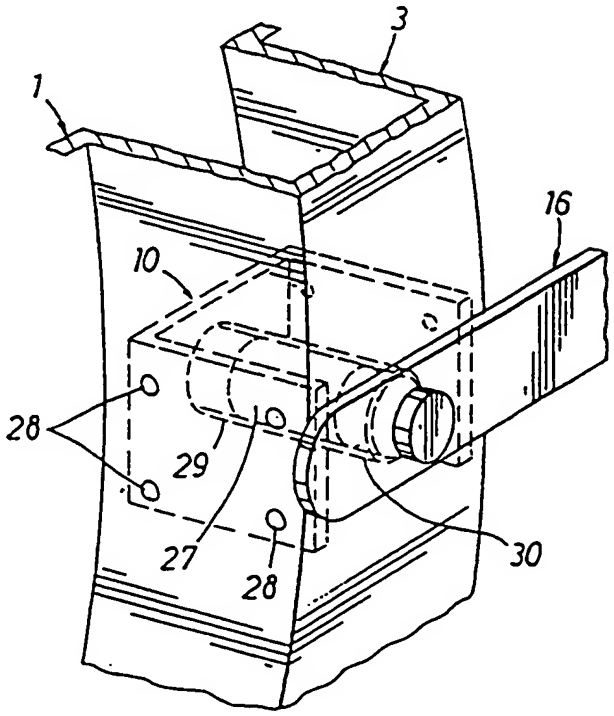


FIG. 10

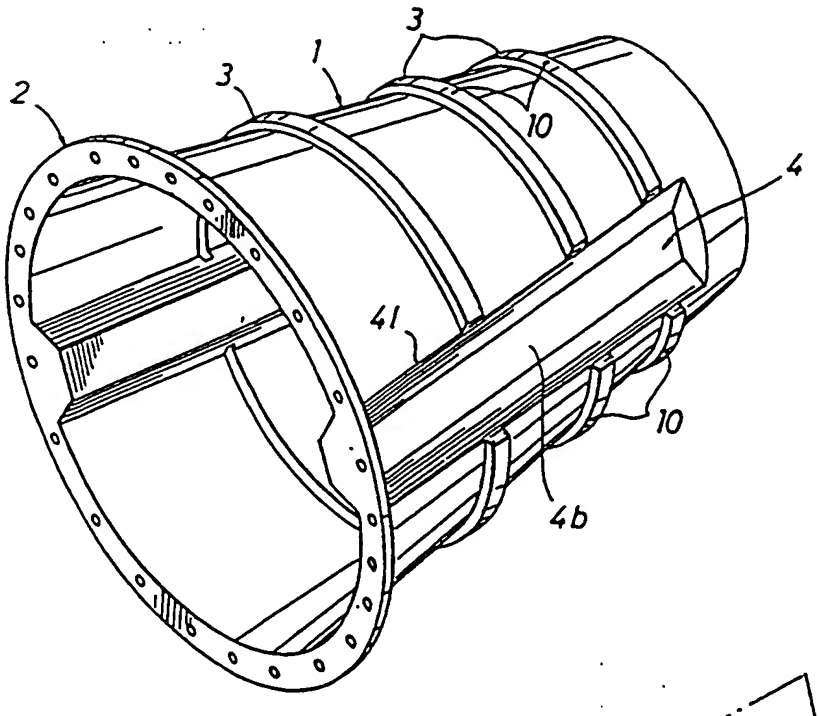


FIG. 11

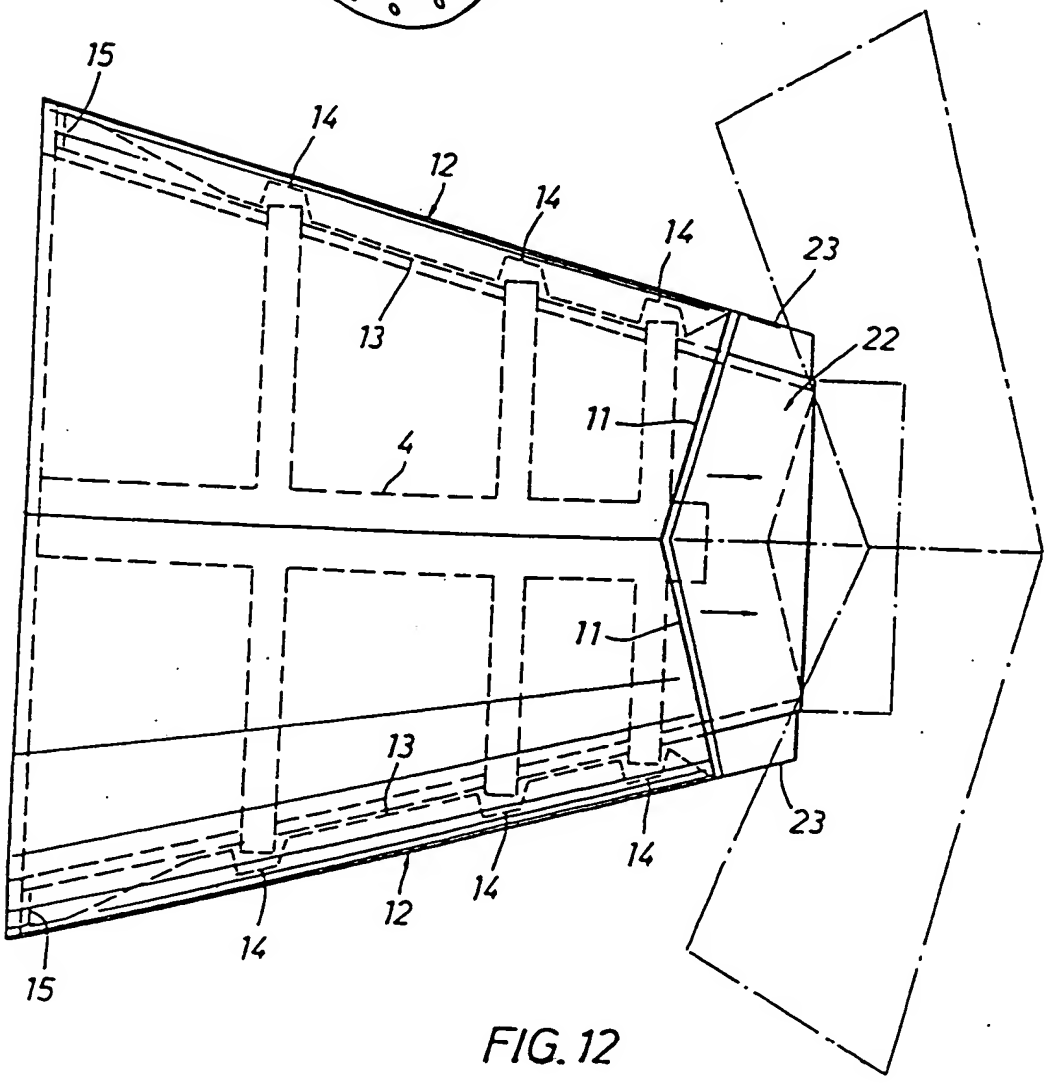
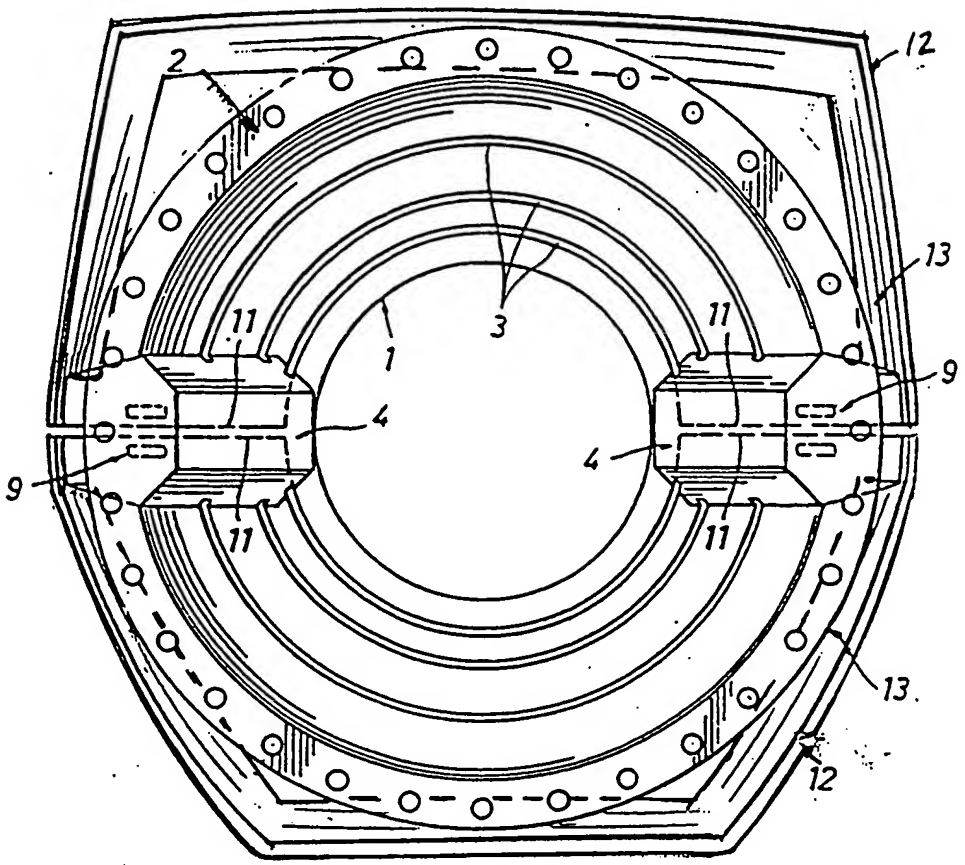


FIG. 12

FIG. 14



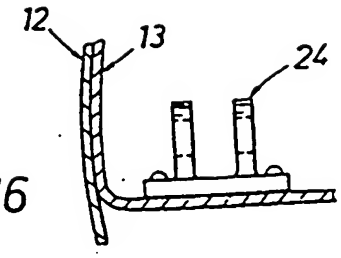


FIG. 16

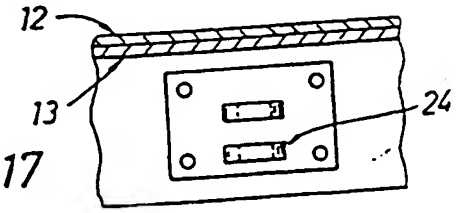


FIG. 17

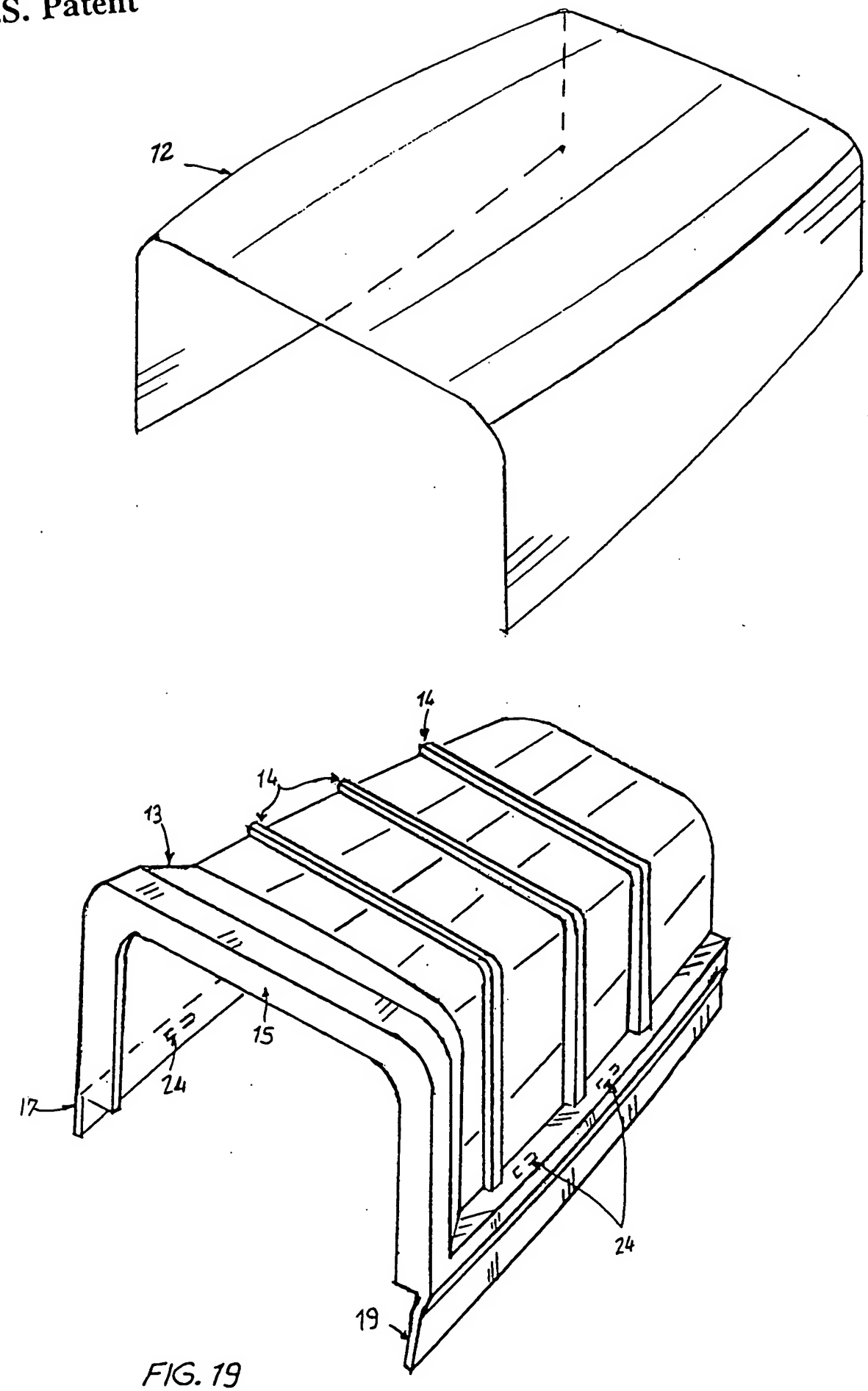


FIG. 19

COPY

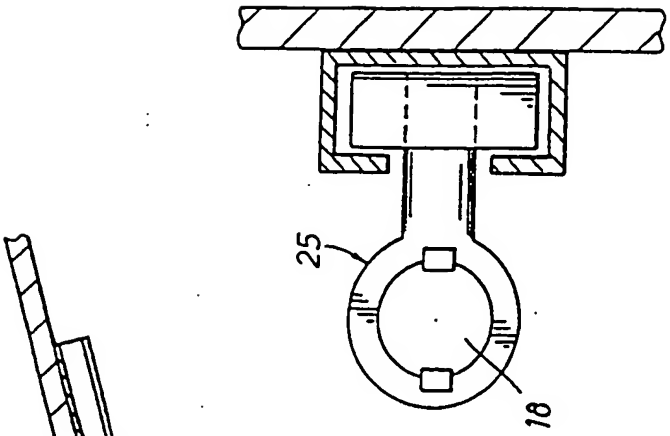


FIG. 24

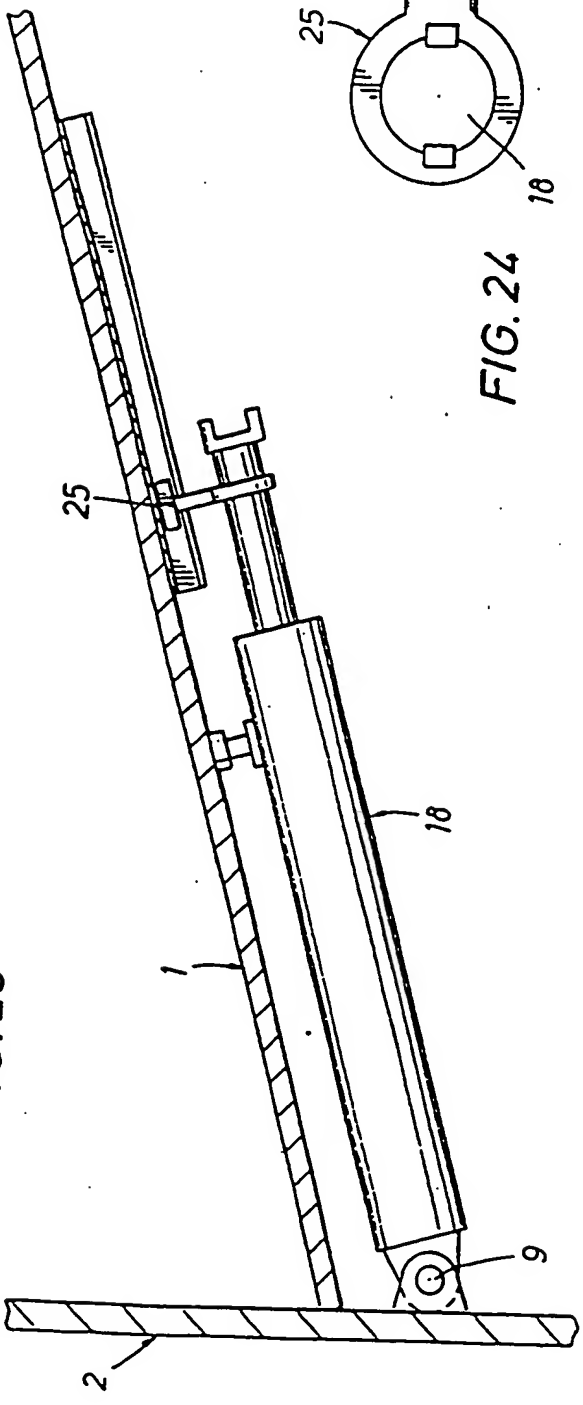


FIG. 23

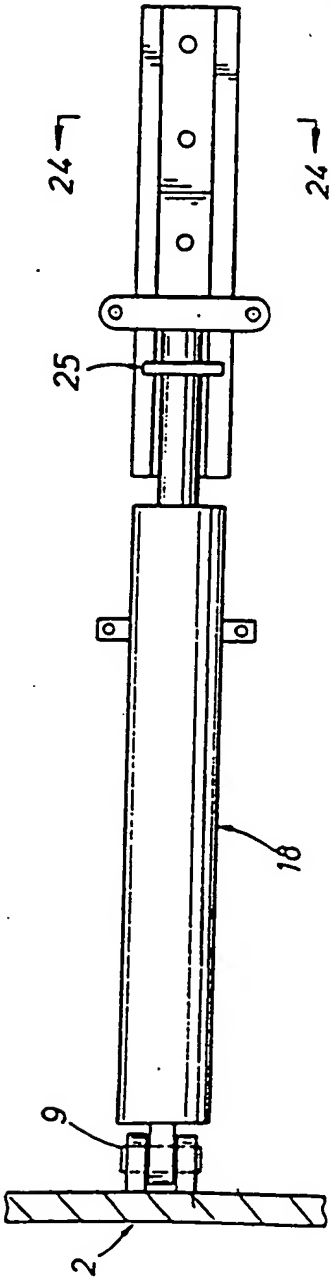


FIG. 22

FIG. 25

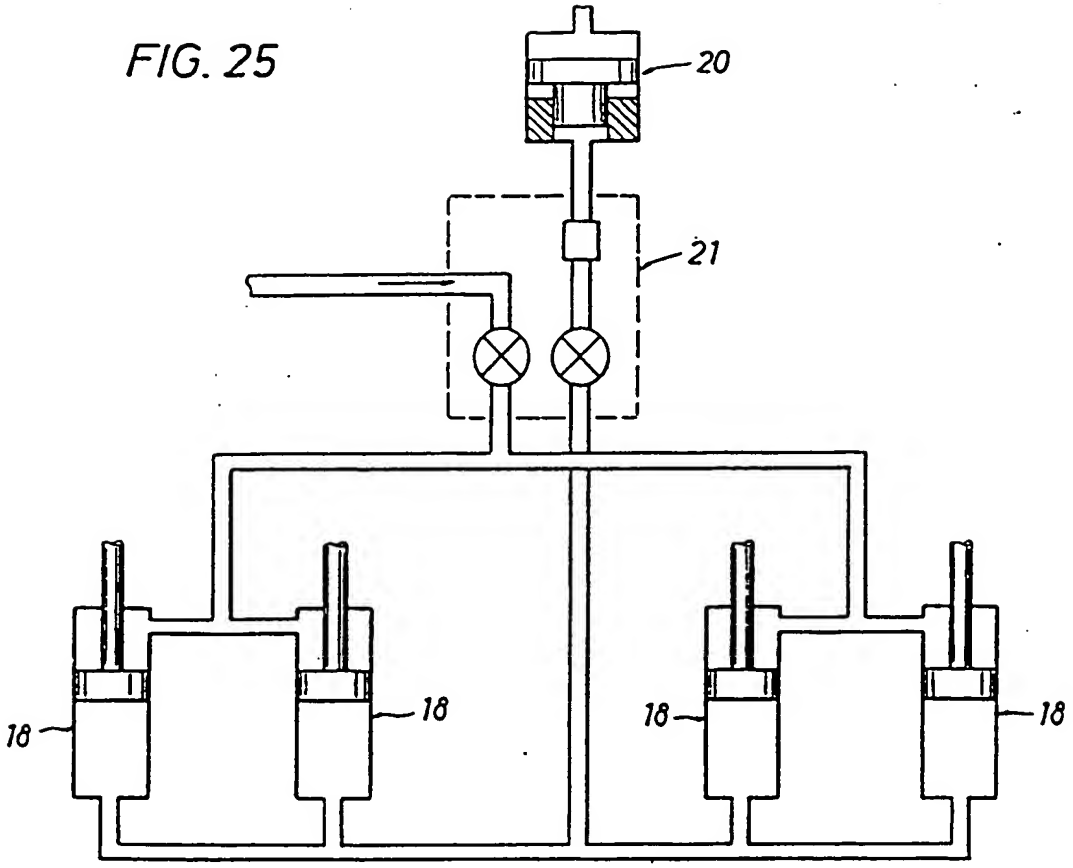


FIG. 26

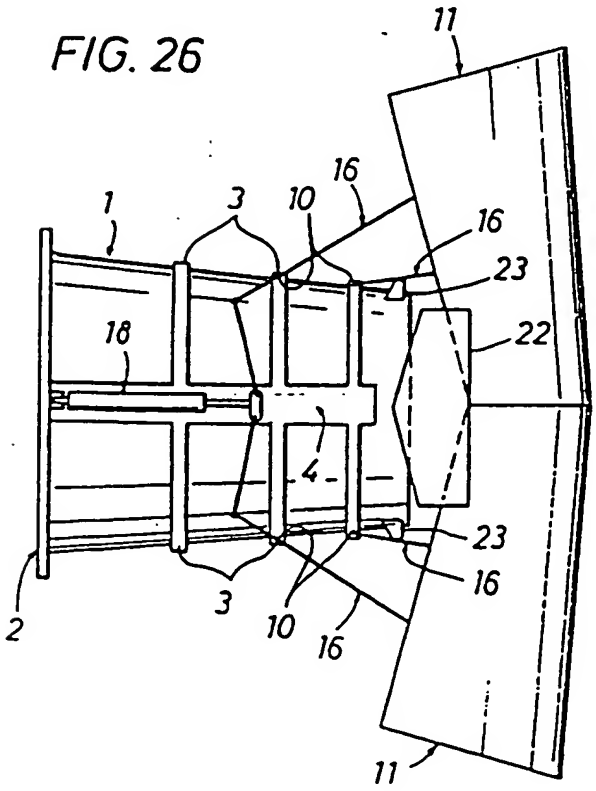
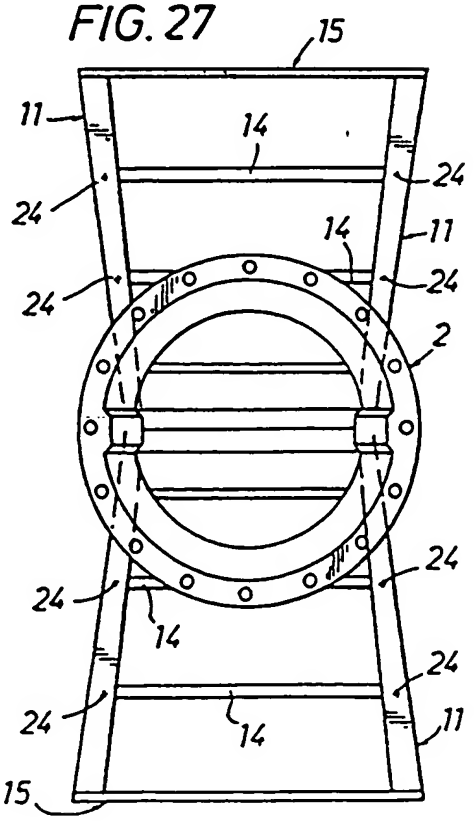


FIG. 27



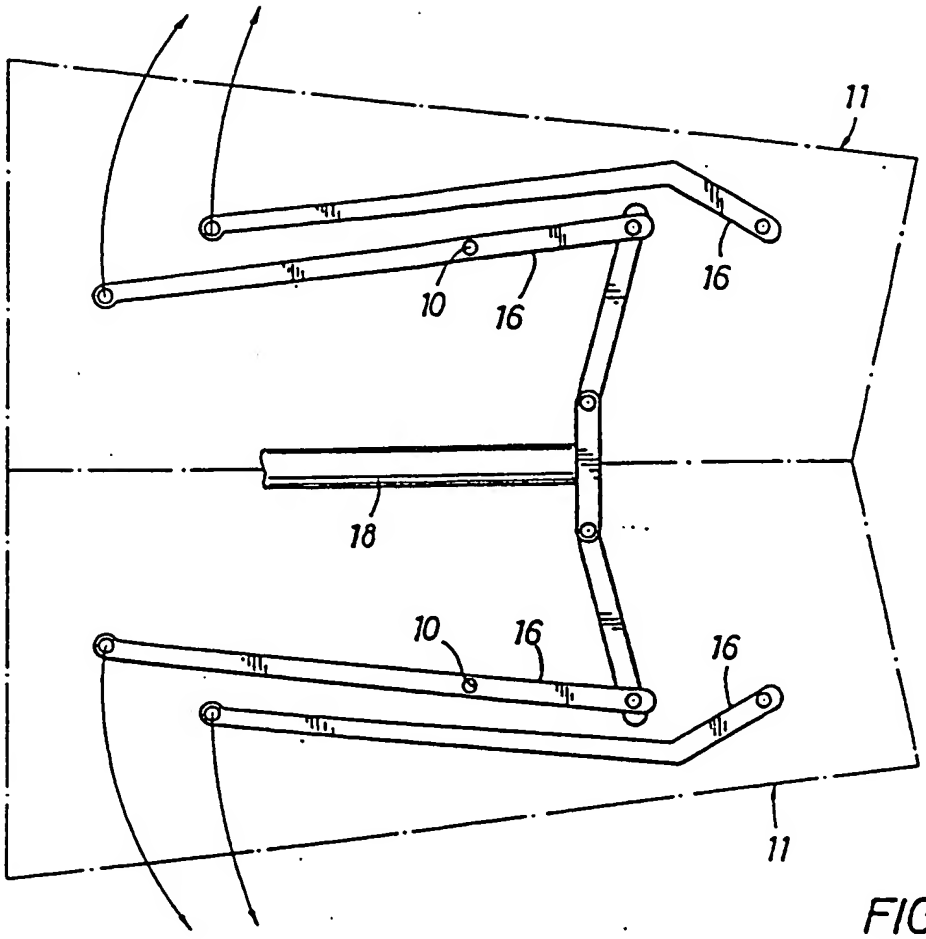


FIG. 28

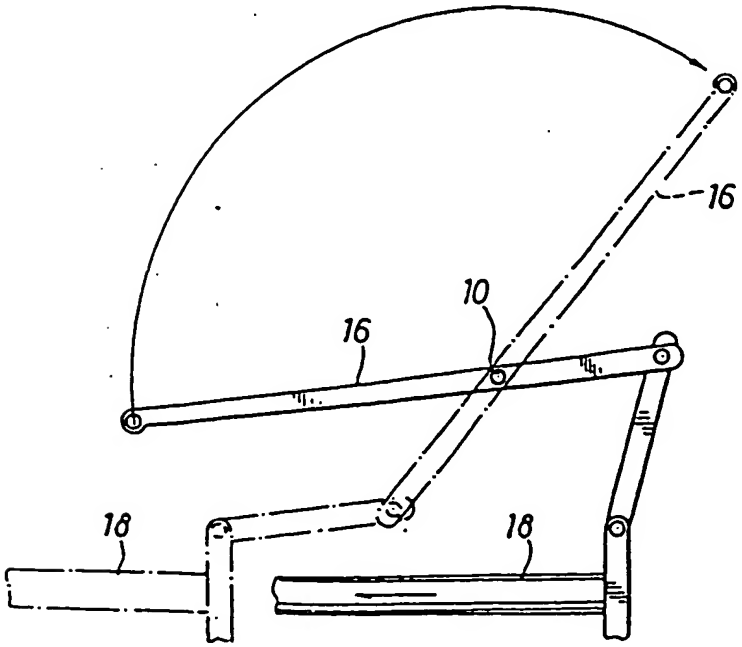


FIG. 29

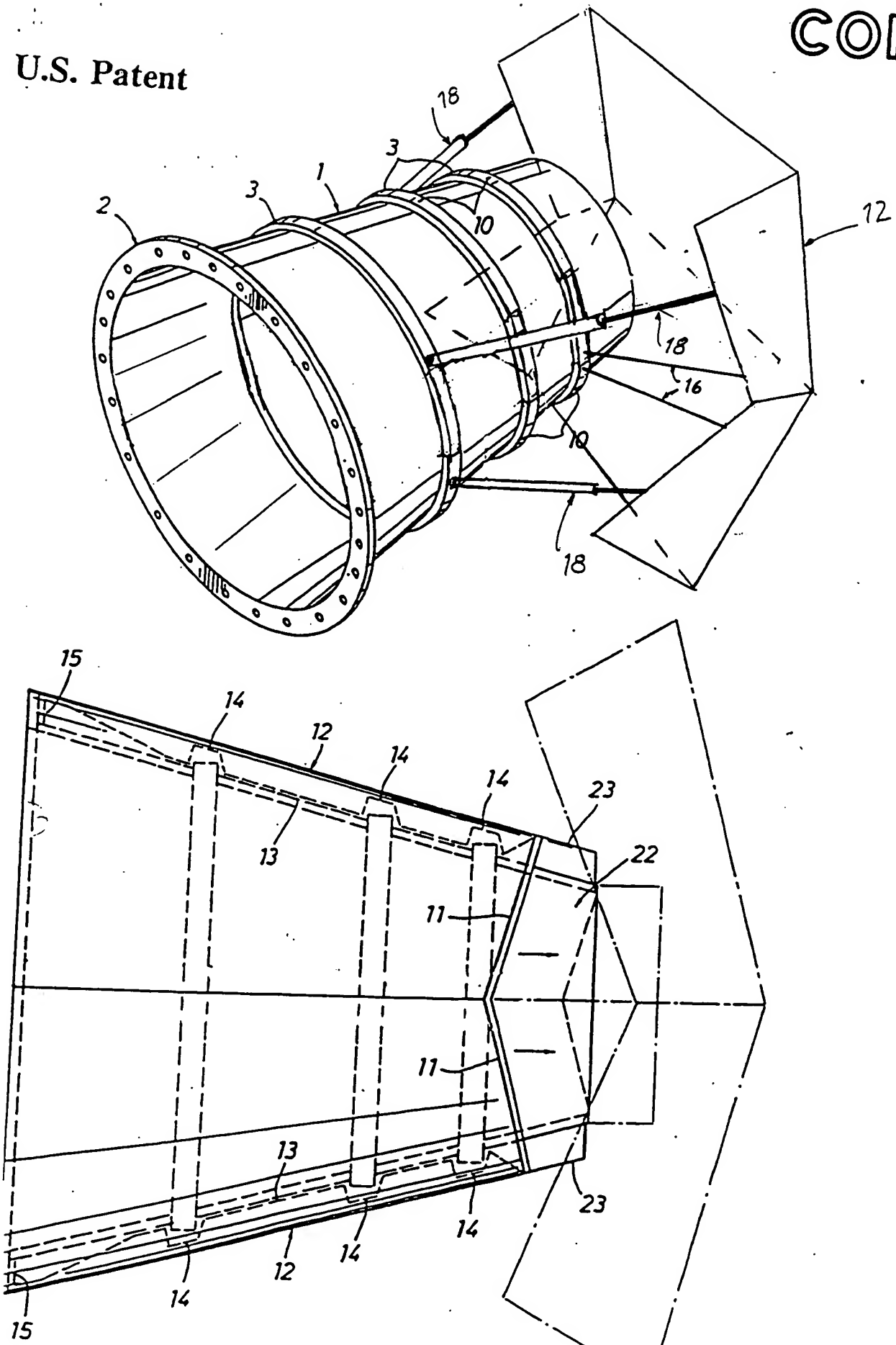

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FIG. 31

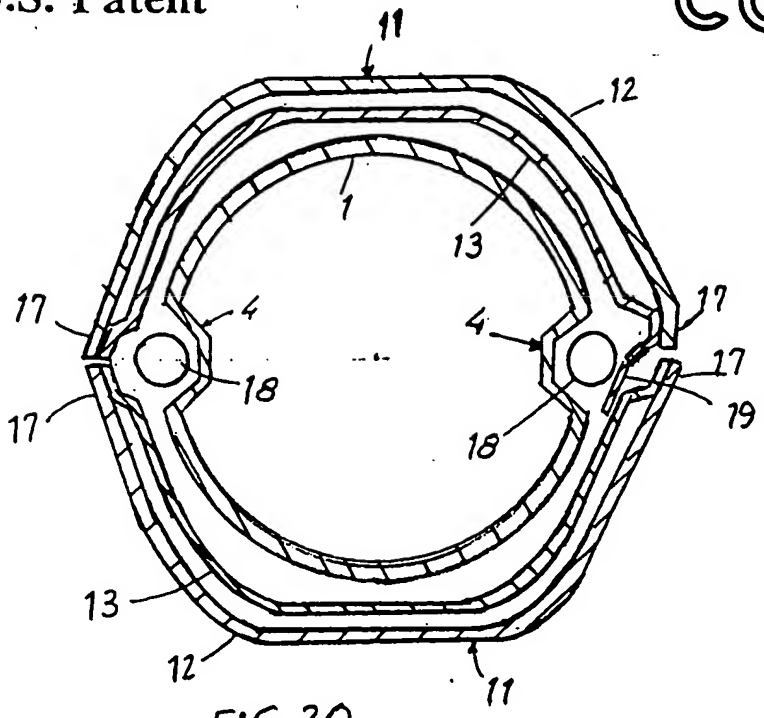


FIG. 20

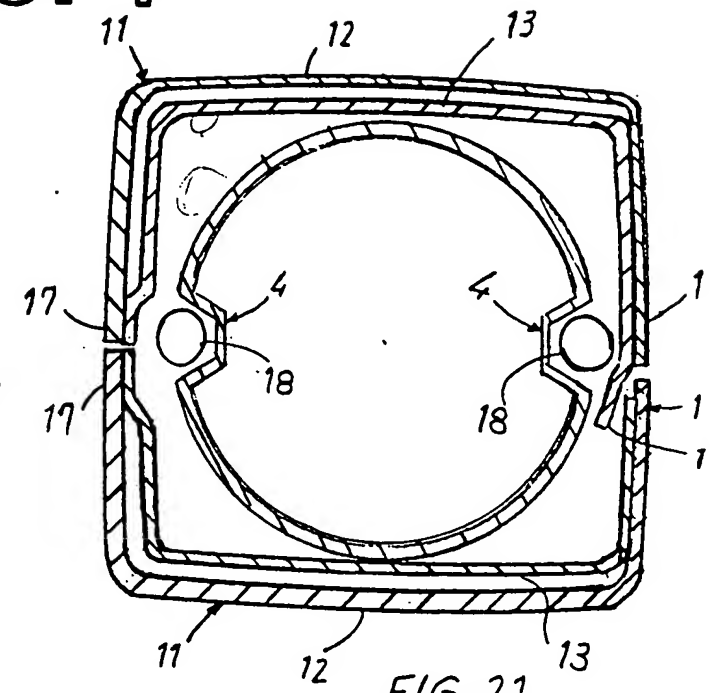


FIG. 21

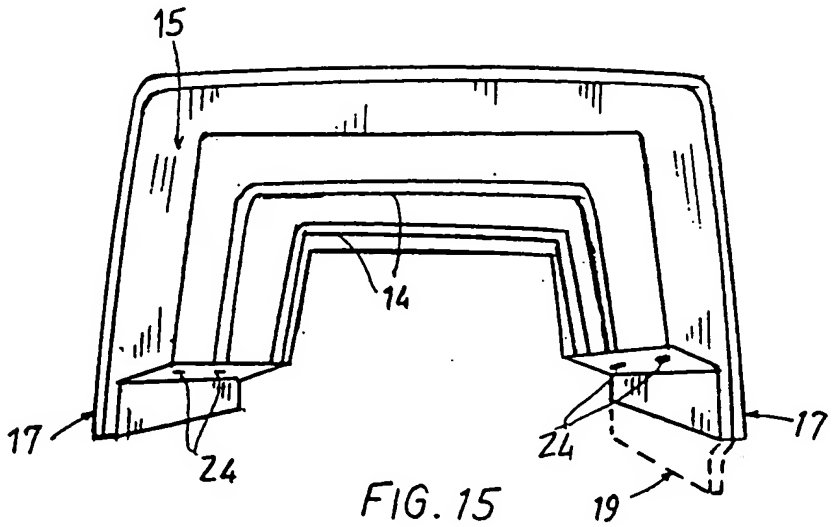
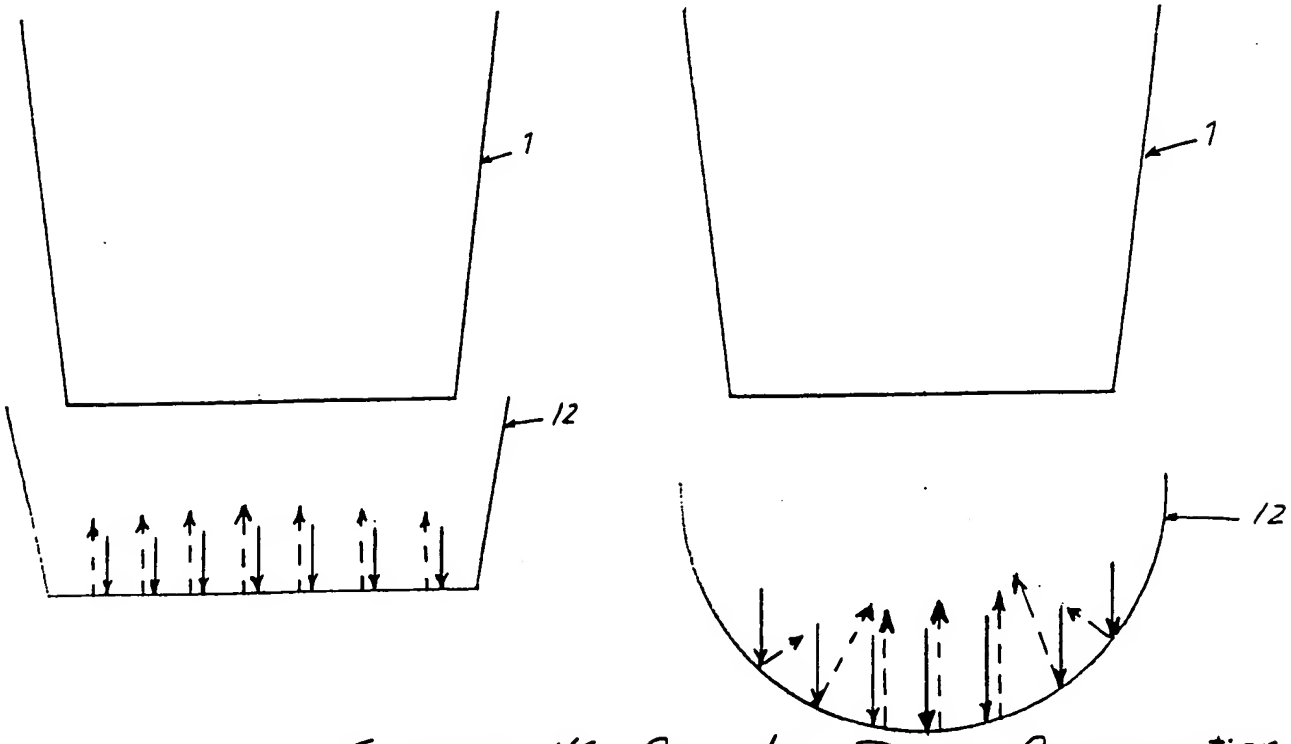


FIG. 15

COPY

——→ Exhaust Gas From Tailpipe

- - - → Reverse Flow Bouncing off Door



Square vs. Circular Door Configuration

FIG. 32

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- Attach this card to the back of the mailpiece, or on the front if space permits.

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X — ☐ Agent ☐ Addressee

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If YES, enter delivery address below: ☐ No

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☐ Insured Mail ☐ C.O.D.

4. Restricted Delivery? *(Extra Fee)* ☐ Yes

2. Article Number *(Copy from service label)*
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PS Form 3811, July 1999 Domestic Return Receipt 102595-00-M-09

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APPLICATION NUMBER	FILING DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	DRAWINGS	TOT CLAIMS	IND CLAIMS
60/192,337	03/27/2000		75	-	1		

Med Osman
1416 Ridgeback Road # D
Chula Vista, CA 91910

Date Mailed: 05/26/2000

Receipt is acknowledged of this provisional Patent Application. It will be considered in its order and you will be notified as to the results of the examination. Be sure to provide the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION when inquiring about this application. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please write to the Office of Initial Patent Examination's Customer Service Center. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the PTO processes the reply to the Notice, the PTO will generate another Filing Receipt incorporating the requested corrections (if appropriate).**

Applicant(s)

Med Osman, Chula Vista, CA ;

Continuing Data as Claimed by Applicant

Foreign Applications

If Required, Foreign Filing License Granted 05/25/2000

-

Title

Square ultra thrust reverser system

Preliminary Class

Data entry by : TRAN, NHU THUY **Team :** OIPE **Date:** 05/26/2000

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Title 37, Code of Federal Regulations, 5.11 & 5.15

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Box1 Missing Parts Provisional,

APPLICATION NUMBER	FILING/RECEIPT DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
60/192,337	03/27/2000	Med Osman	-

Med Osman
1416 Ridgeback Road # D
Chula Vista, CA 91910

Date Mailed: 05/26/2000

NOTICE TO FILE MISSING PARTS OF PROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(c)

Filing Date Granted

An application number and filing date have been accorded to this provisional application. The items indicated below, however, are missing. Applicant is given TWO MONTHS from the date of this Notice within which to file all required items and pay any fees required below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The statutory basic filing fee is insufficient.
  Applicant must submit $ 75 to complete the basic filing fee and/or file a small entity statement claiming such status (37 CFR 1.27).
- To avoid abandonment, a late filing fee or oath or declaration surcharge as set forth in 37 CFR 1.16(e) of $50 for a non-small entity, must be submitted with the missing items identified in this letter.
- **The balance due by applicant is $ 125.**

A copy of this notice MUST be returned with the reply.

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Initial Patent Examination Division (703) 308-1202
PART 1 - ATTORNEY/APPLICANT COPY

Mr. Lover

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PATENT DISCLOSURE

Inventor: Med Osman **Date: March 12, 2000**

Title: THE SQUARE ULTRA THRUST REVERSER SYSTEM

This patent is based on the previous US Patent # 5,615,834. The new thrust reverser system and particularly the door inner and outer skin design, shall be patented under the trade name of the **SQUARE ULTRA REVERSER.**

The **SQUARE ULTRA REVERSER** is a further adaptation of the innovative ideas of the **ULTRA THRUST REVERSER SYSTEM** to design a new lighter, more aerodynamically efficient and easier to manufacture thrust reverser system for aircrafts powered by fan or jet engines at a thrust level up to the low twenty thousand pound of thrust.

The **SQUARE ULTRA REVERSER** uses either a circular or rectangular cross-section for the Tailpipe. The Doors are designed with a flat inner skin to control the reversal process of the exhaust flow from the Jet Engine, in the proper direction along the direction of movement of the vehicle, away from control surfaces.

The design concept of both the **SQUARE ULTRA REVERSER** and the **ULTRA REVERSER,** are unique since they are based on having the reverser built on the Tailpipe. Other types of target thrust reversers such as the 4-Bar or the Single Pivot types are designed either around the tailpipe as is the case of the 4-Bar, or the reverser is the tailpipe as is the case of the Single Pivot design where the doors are an essential portion of the exhaust tailpipe system.

The innovative design concepts are:

1- **An integral exhaust tailpipe construction** which acts as the main structure carrying the various thrust reverser components and transmitting the loads to the engine bulkhead. As in the **ULTRA THRUST REVERSER SYSTEM,** it will consist of integral construction of the frames and the blister in the tailpipe skin to take the loads instead of having the frames as separate details riveted to the tailpipe. However, in the case of the **SQUARE ULTRA REVERSER,** the Tailpipe will be made in either a circular or rectangular cross-section.

   The integral construction will significantly reduce the manufacturing time and cost and result in a lighter and stronger tailpipe construction due to the fact that the hat section acts as two L-sections thereby providing twice as much rigidity as the traditional L-section used in the construction without incurring the weight penalty of a hat section. If acoustic attenuation is needed, specially for turbojet applications, the same process could be utilized where the bonded honeycomb will be sandwiched between an outer and an inner perforated tailpipe bonded together. The inner tailpipe skin will have the integral frames attached to the outer skin. The hat section areas will not have any perforations to enhance structural integrity. A strip of aluminum could also be welded to the hat sections in the

area exposed to the flow to enhance flow characteristics if needed, and/or the structural integrity of the tailpipe. Separate frames can be welded to the inner tailpipe skin, instead of the integral frames.

2- **Square integral construction of the clamshell doors** consisting of an outer aluminum skin and an inner flat skin that can handle high temperature gases, such as nickel based alloys or steel. The inner skin will be flat and have integral corrugations, two or more, depending on the loads, to replace the separate frames that are usually riveted to the outer and inner skins.

3- **The third innovative idea is the elimination of the fairings** on the side of the thrust reverser and the extension of the upper and lower doors outer and inner skins to cover the actuation mechanism in the stow position, as it was done with the **ULTRA THRUST REVERSER SYSTEM** . This approach will eliminate the cost of fabrication and tooling of the fairing as well as reducing the gaps which contribute to increase in drag and most importantly the control and containment of the reverse flow to keep it away from the aircraft control surfaces.

4- **The fourth innovative idea is the extension** of the inboard side of the upper and/or lower doors, as systems integration and compatibility demands, to further divert the exhaust flow in reverse away from the aircraft surface to enhance its stability on the ground during reverse thrust operation. The extension will be designed to underlap along the other door in the stow position along the actuation mechanism.

5- **The fifth innovative idea is the incorporation of movable surfaces** in the aft fairings, to control the Tailpipe exit area to optimize the Jet/Fan engine performance and directional control of the aircraft. From the side fairings and the top fairings, simple or compound control surfaces shall extend fore and/or aft, along guide tracks, thereby causing an increase/reduction in the exit area. These surfaces will be controlled by either hydraulic or other type of motion control, independent from the reverser operation.

OPERATION

The reverse thrust action occurs normally to slow down the aircraft during landing or for backing up and braking action during taxiing operations. When reverse thrust is commanded the clam shell doors will be unlocked and pushed back by the actuators, through linking mechanisms, behind the exhaust tailpipe exit area to direct the exhaust flow forward to slow down the aircraft from its landing speed down to a manageable taxiing speed.

The force resulting from the exhaust flow impingement on the doors shall be taken by the linkages mechanism which in turn dump the loads into the tailpipe integral frames and blister structures to the engine or nacelle bulkhead. Part of the load will also be imparted by the hydraulic actuator body thereby creating a redundant load path providing a fail safe design approach.

Boosted hydraulic pressure to the thrust reverser actuators shall reduce their respective diameters compared to current design approaches, thereby minimizing the impact of the internal blister, to

house the actuators system, on the engine exhaust gas path flow. The smaller actuators will eliminate the need for external blisters protruding in the free stream, thereby closely emulating the performance of the non-reversing tailpipe exhaust system. Fairings protruding in the free stream to cover the actuation system can cause a penalty of increased Specific Fuel Consumption (SFC) due to increased drag of up to 2% during normal cruise in addition to the other penalties caused by base drag, exhaust gas leakage from the tailpipe, gaps and increased weight compared to a non-reversing tailpipe configuration which can all add up to more than four percent increase in SFC.

The elimination of the fairings by extending the doors to cover the actuation system will favorably contribute to reduction in SFC penalty due to gaps between the fairings surfaces and the upper and lower doors and the extensive sealing required to minimize its impact on drag and aircraft performance. The SQUARE ULTRA REVERSER, similar to the ULTRA REVERSER, design minimizes the sealing requirements along the doors compared to all other designs and is much easier to seal since it is in a straight line, the fact that will render its impact on drag and sfc so insignificant and immeasurable.

The elimination of the fairings as well as the elimination of the other detail parts used in the traditional thrust reverser construction not only improves the aerodynamic performance of the thrust reverser system but also significantly contributes to the reduction of manufacturing and tooling design and also improves the overall system reliability due to the significant reduction of number of parts.

The movable fairings can be moved to slide forward or aft to increase/decrease the exit area, thereby optimizing the Jet/Fan engine thrust and fuel consumption. The convergent rectangular aft section of the SQUARE ULTRA REVERSER SYSTEM is similar to a rectangular conic shape, hence the motion of the movable fairings forward will lead to an increase in the exit geometric flow area, also the motion of the movable fairing aft will lead to a decrease of the geometric flow area, for the exhaust gases in the forward thrust mode of operation.

CLOSING STATEMENT

The SQUARE ULTRA REVERSER system provides a unique approach to the design of thrust reverser systems and doors, for aircrafts taking into consideration the forward thrust performance during the aircraft various modes of operation such as Take-off, Climb and Cruise which are critical for the aircraft range, climb and overall performance and marketability.

The design takes advantage of well developed, low risk manufacturing technology such as hydro-forming or super plastic forming to design integrally constructed components using conventional materials which is conducive to significant acquisition and maintenance cost reduction.

The new design which is extremely efficient, light, easy to manufacture, assemble and maintain will have significant impact on the aircraft and power plant performance for new as well as existing aircrafts that can be retrofitted with the new SQUARE ULTRA REVERSER.

Patent Inventor: Med Osman/Aeronautical Engineer

PTO/SB/09 (12-97)
Approved for use through 9/30/00. OMB 0651-0031
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STATEMENT CLAIMING SMALL ENTITY STATUS (37 CFR 1.9(f) & 1.27(b))–INDEPENDENT INVENTOR

Docket Number (Optional): 60/192,337

Applicant, Patentee, or Identifier: Medhat A. Osman

Application or Patent No.: 60/192,337

Filed or Issued: 05/26/2000

Title: Square ULTRA THRUST REVERSER System

As a below named inventor, I hereby state that I qualify as an independent inventor as defined in 37 CFR 1.9(c) for purposes of paying reduced fees to the Patent and Trademark Office described in:

- ☐ the specification filed herewith with title as listed above.
- ☐ the application identified above.
- ☒ the patent identified above.

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Separate statements are required from each named person, concern, or organization having rights to the invention stating their status as small entities. (37 CFR 1.27)

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

NAME OF INVENTOR	NAME OF INVENTOR	NAME OF INVENTOR
Medhat A. Osman		
Signature of inventor	Signature of inventor	Signature of inventor
6/6/2000		
Date	Date	Date

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1. A thrust reverser system for a jet engine, comprising:

a tailpipe having an internal surface in contact with engine internal gas flow, and an outer surface;

a pair of clamshell-type doors, each door comprising a substantially flat center panel, an inboard side panel extending from an inboard longitudinal edge of the center panel, and an outboard side panel extending from an outboard longitudinal edge of the center panel;

said doors moveable between a stowed position, overlaying the tailpipe and out of contact with internal gas flow, and a deployed position, behind the tailpipe, wherein a majority of the internal gas flow impinges directly upon the door center panels.

2. The thrust reverser system of claim 1, wherein the doors contact each other along longitudinal free edges of the side panels when in stowed position, thereby fully surrounding the tailpipe.

3. The thrust reverser system of claim 2, wherein the inboard and outboard side panels are substantially flat.

4. The thrust reverser system of claim 3, wherein the side panels extend at right angles from the center panel, such that both doors together in stowed position define a substantially rectangular cross-section.

5. The thrust reverser system of claim 3, wherein the angle between the side panels and the center panels is substantially greater than a right angle, such that both doors together in stowed position define a hexagonal cross-section.

6. The thrust reverser system of claim 1, further comprising a system of actuators and linkages attached between the tailpipe outer surface and the doors.

7. The thrust reverser system of claim 6, wherein the system of actuators and linkages comprises for each door at least one hydraulic actuator directly linking the tailpipe outer surface to the door.

8. The thrust reverser system of claim 7, wherein the at least one hydraulic actuator is positioned within a cavity between the door and the tailpipe outer surface when the door is in stowed position.

9. The thrust reverser system of claim 7, wherein the at least one hydraulic actuator is positioned within a depression in the outer surface of the tailpipe.

10. The thrust reverser system of claim 6, wherein the system of actuators and linkages comprises, for each door, a pair of pivotally mounted hydraulic actuators directly linking the tailpipe outer surface to the door, and a pair of pivotally mounted rods directly linking the tailpipe outer surface to the door.

11. The thrust reverser system of claim 6, wherein the system of actuators and linkages comprises, for each door, two pair of pivotally mounted hydraulic actuators directly linking the tailpipe outer surface to the door.

21. A thrust reverser system for a jet engine, comprising:

a tailpipe having an internal surface in contact with engine internal gas flow, and an outer surface;

a pair of reverser doors, each door comprising forward and aft ends, and a substantially flat center panel;

said doors moveable between a stowed position, overlaying the tailpipe, and out of contact with internal gas flow, and a deployed position, disposed behind the tailpipe in abutting relation along their aft ends, and wherein a majority of the internal gas flow impinges directly upon the flat center panels.

22. The thrust reverser system of claim 21, wherein the reverser doors further comprise inboard and outboard side panels extending from opposed longitudinal edges of the center panels.

23. The thrust reverser system of claim 22, wherein the side panels are at substantially right angles to the center panels.

24. The thrust reverser system of claim 22, wherein, in deployed position, the flat center panels are positioned substantially perpendicular to the impinging internal gas flow.

25. The thrust reverser system of claim 21, further comprising a first pair of hydraulic actuators directly linking each door to the tailpipe outer surface, and configured to move the doors between the stowed and deployed positions.

26. The thrust reverser system of claim 25, further comprising a second pair of hydraulic atuators directly linking each door to the tailpipe outer surface, and configured to move the doors between the stowed and deployed positions.

31. A thrust reverser system for a jet engine, comprising:

a tailpipe having an internal surface in contact with engine internal gas flow, and an outer surface;

a pair of reverser doors, each door comprising forward and aft ends, and a substantially flat center portion;

at least one hydraulic actuator directly linking each reverser door to the tailpipe outer surface;

said doors moveable between a stowed position, overlaying the tailpipe, and out of contact with internal gas flow, and a deployed position, disposed behind the tailpipe in abutting relation along their aft ends, and wherein said flat center portion deflects the internal gas flow.

32. The thrust reverser system of claim 31, wherein said at least one hydraulic actuator comprises a first pair of hydraulic actuators.

33. The thrust reverser system of claim 32, further comprising a second pair of hydraulic actuators directly linking each reverser door to the tailpipe outer surface.

34. The thrust reverser system of claim 31, wherein the reverser doors further comprise substantially flat inboard and outboard side panels.

35. The thrust reverser system of claim 31, wherein the inboard and outboard side panels extend at a right angle from the door center portions.

36. The thrust reverser system of claim 34, wherein the reverser doors fully surround the tailpipe when in stowed position.

James L. Farmer,
511 E. Concorda Dr.
Tempe, Arizona 85282

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Serial/Patent No.: not available yet
Filing/Issue Date: 3/27/01
Inventor(s): Ned Ostuan
Title: Square Ultra Thrust Reverser

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Docket No.: 003.0001 Atty: JLF

JAMES L. FARMER
TRICIA L. FARMER
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APPLICATION NUMBER	FILING OR 371 (c) DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
10/042,737	08/29/2002	Medhat A. Osman	003.0001

CONFIRMATION NO. 8228

James L. Farmer
511 E. Concorda Dr.
Tempe, AZ 85282

FORMALITIES LETTER

OC0000000014273466

OC0000000014273466

Date Mailed: 11/04/2004

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items and pay any fees required below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The statutory basic filing fee is missing.
  Applicant must submit $ 395 to complete the basic filing fee for a small entity.
- The oath or declaration is missing.
  A properly signed oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.
- To avoid abandonment, a late filing fee or oath or declaration surcharge as set forth in 37 CFR 1.16(e) of $65 for a small entity in compliance with 37 CFR 1.27, must be submitted with the missing items identified in this letter.

The application is informal since it does not comply with the regulations for the reason(s) indicated below.

The required item(s) identified below must be timely submitted to avoid abandonment:

- A substitute specification in compliance with 37 CFR 1.52, 1.121(b)(3), and 1.125, is required. The specification, claims, or abstract page(s) submitted is not acceptable and cannot be scanned or properly stored because:
  - The line spacing on the specification, claims, or abstract is not 1½ or double spaced (see 37 CFR 1.52(b)).
- An abstract of the technical disclosure not exceeding 150 words in length and commencing on a separate sheet in compliance with 37 CFR 1.72(b) is required. An abstract was not provided for this application.

The applicant needs to satisfy supplemental fees problems indicated below.

The required item(s) identified below must be timely submitted to avoid abandonment:

- Additional claim fees of **$144** as a small entity, including any required multiple dependent claim fee, are required. Applicant must submit the additional claim fees or cancel the additional claims for which fees are due.

SUMMARY OF FEES DUE:

Total additional fee(s) required for this application is **$604** for a Small Entity

- **$395** Statutory basic filing fee.
- **$65** Late oath or declaration Surcharge.

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  - **$144** for **16** total claims over 20.

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PART 2 - COPY TO BE RETURNED WITH RESPONSE

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__ Continuation __ CIP __ Divisional __ PCT __ RCE
__ Foreign Priority claimed ____ Pages of Specification
__ NumberofClaims __ Sheets of Drawings __ Abstract
✓ Declaration ✓ Power of Attorney ✓ Check $604
✓ Authorization to charge Deposit Account 50-1753
(50220)
__ Assignment ___ Small Entity Statement
__ Information Disclosure Stmt. ___ Transmittal
__ Amendment ___ Issue Fee ___ Formal Drawings
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Other Response to Notice to file Missing Parts (Substitute Spec.)

Inventor Medhat A. Osman

Client _____

Title Square Ultra Thrust Reverser System

Serial No. 10/042,737

Due Date 1/4/05 Atty SZS

Docket No. 05655 Matter No. 50220

Express Mail # EL977589733US

Date Mailed 1/3/05

1

MEDHAT OSMAN
PH. 480-926-2044
2316 E. CATHY CT.
GILBERT, AZ 85296

16-24/1220 4246

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APPLICATION NUMBER	FILING OR 371 (c) DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
10/042,737	08/29/2002	Medhat A. Osman	003.0001

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Tempe, AZ 85282

FORMALITIES LETTER

OC000000014273466

OC000000014273466

Date Mailed: 11/04/2004

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

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The application is informal since it does not comply with the regulations for the reason(s) indicated below.

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- A substitute specification in compliance with 37 CFR 1.52, 1.121(b)(3), and 1.125, is required. The specification, claims, or abstract page(s) submitted is not acceptable and cannot be scanned or properly stored because:
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  - **$144** for **16** total claims over 20.

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PART 2 - COPY TO BE RETURNED WITH RESPONSE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s): Medhat A. Osman

Application No.: 10/042,737

Filed: 08/29/02

Art Unit:

Title: Ultra Thrust Reverser System

Attorney Docket No.: 50220

RESPONSE TO NOTICE TO FILE MISSING PARTS OF APPLICATION

Commissioner for Patents
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Alexandria, VA 22313-1450

Sir:

This is in response to a Notice to File Missing Parts of Application under 37 CFR 1.53(f). Enclosed is a copy of said Notice and the following documents and fees to complete the filing requirements of the above-identified application.

(X) Executed Declaration and Power of Attorney. The above-identified application is the same application which the inventor executed by signing the enclosed declaration. (2 copies)

(X) Statutory basic filing fee $395.00 (X)Utility ( ) Design

(X) Substitute specification

(X) Additional claim fees of $144.00

(X) Missing Parts Surcharge $65.00

( ) A Petition for Extension of Time for reply to Notice of Missing Parts is attached.

- ( ) one month $55.00
- ( ) two months $210.00
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(X) It is believed that no request for extension of time or fees are due. Notwithstanding, the Commissioner is authorized to charge any additional fees incurred or credit any overage to Deposit Account No.50-1753 (50220). Please regard this as a further request for extension of time to the extent one is needed. (Customer Account Number 22929)

Respectfully submitted,

By _____
Sue Z. Shaper

Reg. No. 31663

Date: 1/3/5

Telephone No.: 713 550 5710

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Typed Name: Sue Z. Shaper

Signature: _____

PATENT APPLICATION

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION	ATTORNEY DOCKET NO. 50220

As a below named inventor, I hereby declare that:

My residence/post office address and citizenship are as stated below next to my name;

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Square Ultra Thrust Reverser System

the specification of which is attached hereto unless the following box is checked:

(x) was filed on 8/29/02 as US Application Serial No. or PCT International Application Number 10/042,737 and was amended on _____ (if applicable).

I hereby state that I have reviewed and understood the contents of the above-identified specification, including the claims, as amended by any amendment(s) referred to above. I acknowledge the duty to disclose all information which is material to patentability as defined in 37 CFR 1.56.

Foreign Application(s) and/or Claim of Foreign Priority

I hereby claim foreign priority benefits under Title 35, United States Code Section 119 of any foreign application(s) for patent or inventor(s) certificate listed below and have also identified below any foreign application for patent or inventor(s) certificate having a filing date before that of the application on which priority is claimed:

COUNTRY	APPLICATION NUMBER	DATE FILED	PRIORITY CLAIMED UNDER 35 U.S.C. 119
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Provisional Application

I hereby claim the benefit under Title 35, United States Code Section 119(e) of any United States provisional application(s) listed below:

APPLICATION SERIAL NUMBER	FILING DATE

U.S. Priority Claim

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code Section 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, Section 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

APPLICATION SERIAL NUMBER	FILING DATE	STATUS(patented/pending/abandoned)

POWER OF ATTORNEY:

As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) listed below to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

Sue Z. Shaper, Reg. No. 31663

Send Correspondence to:	Direct Telephone Calls To:
Sue Z. Shaper 1800 West Loop South, Suite 1450 Houston, Texas 77027	Sue Z. Shaper 713 550 5710

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of Inventor: Medhat A. Osman Citizenship: US

Residence: 2316 Cathy Ct., Gilbert, AZ 85296

Post Office Address: Same

Inventor's Signature Date 12/10/04

50220 dec and POA for missing parts

PATENT APPLICATION

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

ATTORNEY DOCKET NO. 50220

As a below named inventor, I hereby declare that:
My residence/post office address and citizenship are as stated below next to my name;
I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:
Square Ultra Thrust Reverser System
the specification of which is attached hereto unless the following box is checked:
(x) was filed on 8/29/02 as US Application Serial No. or PCT International Application
Number 10/042,737 and was amended on _____ (if applicable).
I hereby state that I have reviewed and understood the contents of the above-identified specification, including the claims, as amended by any amendment(s) referred to above. I acknowledge the duty to disclose all information which is material to patentability as defined in 37 CFR 1.56.

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Provisional Application
I hereby claim the benefit under Title 35, United States Code Section 119(e) of any United States provisional application(s) listed below

APPLICATION SERIAL NUMBER	FILING DATE

U.S. Priority Claim
I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code Section 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, Section 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

APPLICATION SERIAL NUMBER	FILING DATE	STATUS(patented/pending/abandoned)

POWER OF ATTORNEY:
As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) listed below to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

Sue Z. Shaper, Reg. No. 31663

Send Correspondence to:	Direct Telephone Calls To:
Sue Z. Shaper 1800 West Loop South, Suite 750 Houston, Texas 77027	Sue Z. Shaper 713 550 5710

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon

Full Name of Inventor: Med Oswan Citizenship: USA
Residence: 2316 E. Cathy Ct. - Gilbert, AZ 85296
Post Office Address: Same

Inventor's Signature Date 12/10/2002

50220 dec and POA for missing parts

Square Ultra Thrust Reverser System

Inventors: Medhat A. Osman

FIELD OF THE INVENTION

This invention relates to thrust reverser systems for aircraft jet engines, based on the ULTRA THRUST REVERSER SYSTEM U.S. Patent 5,615,834. This patent relates to Applicant's Disclosure Document filed March 27, 2000, application number 60/192,337.

BACKGROUND OF THE INVENTION

Thrust reverser systems are used to decelerate a jet aircraft, and in particular to slow it down after landing, to slow it down during taxiing, and to aid it to back-up from a tight spot or a gate if needed. Reversing the exhaust jet flow from the engines provides the desired deceleration, especially on short runways, and slows down the aircraft to a safe taxiing speed thereby allowing the pilot to use the brakes on the taxiways.

Previous designs such as U.S. Pat. Nos. 2,968,150 and 3,610,534, sometimes referred to as four bar designs, the thrust reverser is built around the exhaust tailpipe. However, the protrusion of the actuation mechanism into the free air stream surrounding the reverser system, or engine nacelle, has the disadvantage of possibly incurring significant external drag which can penalize aircraft performance in various modes of operation and higher weight penalty.

U.S. Pat. No. 4,129,269, referred to in the industry as the single-pivot design, provides a light construction thrust reverser concept in which the movable doors and a reduced tailpipe form the exhaust system in forward thrust. The single-pivot design has the disadvantage of possibly permitting leakage of the internal engine gas flow between the stowed doors and the tailpipe. Exhaust flow leakage through the door/tailpipe system, do adversely impact engine thrust performance, fuel consumption and overall aircraft performance.

The ULTRA THRUST REVERSER SYSTEM is built on a continuous tailpipe to minimize external drag, while avoiding the drawbacks of leakage from the exhaust tailpipe. Exhaust plumes from both of the aforementioned conventional reverser designs are known to sometimes affect the aircraft control surfaces during reverse thrust operation. Both aforementioned designs therefore can require additional external surfaces to be attached to the aircraft pylon or other methods to divert the plume away from such control surfaces. Those

additional external surfaces, mandated by considerations of compatibility and systems integration of the reverser with the aircraft, add further cost, weight, potential drag and vibration.

The new SQUARE ULTRA THRUST REVERSER SYSTEM design of the present invention optimizes primarily reverse thrust performance by re-designing the shape of the inner door surface to make it flat compared to the existing circular configurations, to maximize the efficiency of reverse flow in the forward direction and to reduce the likelihood of exhaust plume impingement on the aircraft surfaces. In the forward thrust mode, the SQUARE ULTRA is similar to the ULTRA THRUST REVERSER SYSTEM, in the fact that it comprises the design features which optimize forward thrust performance during the various modes of forward flight, and especially during the cruise mode where the aircraft spends most of its flight time. The new design preserves the prior design features in the same manner by combining lighter construction with the primary goal of optimizing internal and external flow aerodynamic characteristics. The rectangular/trapezoidal door design deals effectively with aircraft/thrust reverser integration and compatibility issues, primarily the plume impingement on the aircraft control surfaces, discussed above, by using the sides of the rectangular doors as a buffer to prevent exhaust gases from escaping laterally and impinging on the aircraft surfaces, thereby providing an integrated means to control the plume and divert it away from the aircraft control surfaces. The reverse thrust efficiency is increased by using flat surfaces in the door design to deflect the majority of exhaust gases forward. The new design combines all the characteristics of the ULTRA THRUST REVERSER SYSTEM in addition to better reverse flow performance.

The housing design, in general, for the reverser system, including the actuators and the associated operating mechanism, can adversely affect the external air flow around the tailpipe causing external drag (due to the protrusion of reverser mechanisms in the free air stream around the nacelle thereby causing excessive drag during flight as in the case of the conventional four bar design. The housing design disclosed herein is based on the ULTRA REVERSER design, wherein it benefits from the fact that its housing not only affords no leakage path in the internal gas flow, but also that its housing does not protrude into the free air stream around the nacelle. Conventional single pivot reverser designs have the potential for significant flow leakage between such doors and the rest of the tailpipe. This defect is compounded by a further inability of that design to control the tailpipe exit area which adversely affects forward thrust. These two defects

of this particular conventional housing design severely affect the engine's fuel consumption and performance, penalizing the aircraft's overall performance and range. On the other hand, excessive drag during flight incurred by the other conventional four bar housing design also penalizes the aircraft's overall performance and range. This drag is eliminated by using the housing design approach used on the ULTRA REVERSERSYSTEM.

Conventional construction techniques for target type thrust reverser components, single pivot or four bar, rely heavily on riveting together individual details and subassemblies of hardware, such as frames, inner skin, outer skin and other detail parts, A multitude of pieces of hardware and the extensive use of riveting increases the system weight as well as development, tooling and manufacturing costs. These aspects of design are adversely reflected in the aircraft's gross weight, payload, performance and cost of operation. The present invention is based on the lighter construction approach disclosed on the ULTRA REVERSER SYSTEM, including an integral exhaust tailpipe and integral rectangular/trapezoidal clamshell door construction, actuators and control systems. Integral construction of the tailpipe and doors provide a lighter, stronger structural system compared to conventional construction methods which are heavier, and labor intensive. The new system requires less investment in tooling. The incorporation of the side fairings into the rectangular/trapezoidal doors of the new design improves aerodynamic performance by providing blockage for plumes to prevent escaping and impingement on the aircraft fuselage and/or control surfaces, reduces gaps, and contributes to the reduction of external drag characteristics for better fuel consumption and enhances the overall aircraft/engine performance. The new SQUARE ULTRA design, like the ULTRA THRUST REVERSER SYSTEM uses two actuators to deploy the doors or in other configuration where four actuators are used to deploy the doors.

SUMMARY OF THE INVENTION

The invention comprises a rectangular/trapezoidal target doors for a thrust reverser system for jet engines. The rectangular/trapezoidal doors provide a relatively flat surface configuration facing the incoming exhaust gases, which in turn help deflect the exhaust gases forward in a more uniform fashion, thereby reducing the possibility of deflection of exhaust gases laterally thereby resulting in some of the exhaust gases/plumes impinging on the aircraft surfaces.

The side surfaces of the rectangular/trapezoidal doors, act as a strong buffer blocking lateral plumes, thereby minimizing the possibility of impingement on the aircraft surfaces and keeping the majority of the reverse exhaust flow contained by the doors to exert forward decelerating action.

With the rectangular/trapezoidal door shapes, a new actuation system configuration system is used in the SQUARE ULTRA REVERSER SYSTEM where in an alternate configuration each door is driven by two actuators mounted directly between the tailpipe and the doors providing direct motive force to deploy the doors eliminating the driver link mechanism used in the ULTRA THRUST REVERSER SYSTEM. Therefore the SQUARE ULTRA REVERSER SYSTEM can be designed with either actuation/door deployment arrangement.

The reverser system includes a tailpipe, attached clamshell doors and actuators, including linkage, for moving the doors. The actuators and linkage attach between the tailpipe and the doors and move the doors between a stowed position, out of contact with the internal engine gas flow, to a deployed position, diverting internal engine gas flow aft of the tailpipe.

In the preferred embodiments the actuators are housed together with the tailpipe and doors, either on the sides in an internal blister or in the door corners, to form a protrusion free surface for external free air flow over the thrust reverser system area or nacelle similar to the ULTRA THRUST REVERSER SYSTEM.

The actuators may be connected to a pressure booster system to minimize their size. In preferred embodiments the tailpipe comprises a corrugated body. These body corrugations include annularly structured ridges or hats and axially structured depressions or blisters formed with on or in the tailpipe skin. Preferably, the actuators attach to the tail pipe so as to be located in the axial body depressions, and portions of the actuator linkage attach to annular ridge corrugations of the tailpipe body. Acoustical material may be attached over the surface of the tailpipe. In other configuration, four actuators, one at each corner of the door, are used to drive the target doors, thereby eliminating the need for axial body depressions in the tailpipe and eliminating a portion of the actuation linkages.

In preferred embodiments the clamshell doors also have a corrugated body, comprising a smooth outer skin bonded to a corrugated inner skin, In the preferred embodiments the clamshell doors form a pair of semi-rectangular/trapezoidal doors.

One door, in addition, may include a body extension or fairing, in the side direction. Such a door body extension would underlie a portion of the second door in the stowed position. The thrust reverser system may include an aft fairing attached to the tailpipe, a portion of which may be movable from a stowed position out of contact with the flow of the internal engine gas to a deployed position extending rearward of the tailpipe to further guide internal engine gas flow aft of the tailpipe. Preferably, the movable portion of the aft fairing would comprise two sections. Actuators or motors could move these movable portions.

BRIEF DESCRIPTION OF THE DRAWINGS

A better understanding of the present invention can be obtained from the detailed description of exemplary embodiments set forth below, to be considered in conjunction with the attached drawings, in which;

FIGS. 1 and 2 illustrate, by side plan and cross section views, respectively, an integral tailpipe construction, wherein three integral annular corrugated hat or rib sections, for the purpose of discussion, are shown as providing structural integrity, and one axial depression is indicated with attachment points for the actuators.

FIGS. 3 and 6 illustrate, by side plan view and cross section, a tailpipe design (with stowed rectangular/trapezoidal doors indicated in dashed line in the former), the design making provision for an acoustic treatment of the tailpipe.

FIG. 4 illustrates by detail drawing an option of covering an interior base of a corrugated hat section of the tailpipe (or the door) with a strip of material.

FIGS. 7,3b and 10 illustrate side plan and detail views, respectively, of a tailpipe including cross section details of an attachment point for connecting a link to the tailpipe.

FIGS. 5, 8 and 9 illustrate an end view of the tailpipe, forward looking aft, indicating the axial depressions that form the internal blisters to house the actuators, as well as details of the actuator forward mounts on both sides of the tailpipe flange, respectively,

FIG. 11 illustrates in perspective a tailpipe.

FIG. 12 illustrates a side plan view of the upper and lower doors over the tailpipe, which doors constitute the outer surface of the nacelle surface in the stowed position, with the deployed position indicated in dashed lines, and including aft fairing for the tailpipe;

FIG. 12 also indicates the corrugating mating door integral hat sections with an integral end kicker plate arrangement as well as integral door frames inner skin,

FIG. 13 illustrates in plan view the doors overlying the tailpipe and fixed and moveable aft fairings, with an indication of the internal blisters that house the actuators.

FIGS. 14 A & B illustrate an end view of the doors over the tailpipe, forward looking aft into the tailpipe, indicating in particular a cavity formed between the door edges over the tailpipe internal blisters for housing an actuator on each side of the tailpipe. The upper door is rectangular while the lower door is shown as trapezoidal, which is the alternate configuration for the door invention. In FIG.14 B the tailpipe does not have an internal blister since the door is deployed using four actuators located at the corners of the doors.

FIG. 15 illustrates in end view a door indicating attachment points for the links and a side fairing combined with the door skin.

FIGS. 16 and 17 illustrate details of the attachment point.

FIG. 18 illustrates in side plan view the inner skin of the door, showing the integral frame sections, the end plate, the attachment fittings and indicating the underlap feature.

FIG. 19 illustrates a door inner and outer skin in perspective showing the Square design shape to improve the containment of the exhaust plumes using the straight surfaces forming the sides of the doors, versus the circular door shapes used in the aforementioned patents.

FIGS. 20 and 21 show cross-sections of a door and tailpipe, not at a hat or rib and at a hat or rib, respectively, illustrating the integral fairings arrangement, the underlap extension concept, the actuators position and the internal tailpipe blisters. FIG. 20 shows a trapezoidal door configuration while FIG. 21 shows a rectangular door configuration which both fall under the SQUARE ULTRA REVERSER design concept.

FIGS. 22, 23 and 24 illustrate the actuator system, its attachment to the tailpipe and an actuator piston anti-rotation arrangement.

FIG. 25 illustrates a hydraulic system with an intensifier for supplying high pressure hydraulic fluid to the actuators for each thrust reverser, the illustration assumes a two engine configuration, with two actuators per engine for simplicity though other configuration for same patent uses four actuators per engine. Each actuator having two ports, one for deployment and the other for stow operations, and where hydraulic and electric controls for sequence of

deployment and restow have been simplified, for discussion purposes, since they are similar to current practices mandated by the airworthiness regulations for safe operation of thrust reverser systems.

FIGS. 26 and 27 illustrate the reverser system in deployment position with the general arrangement of the actuator, the connecting links, the fixed and movable fairings and the tailpipe, a side view and an end view, forward looking aft.

FIG. 28 shows the general arrangement of the actuation system, links and hydraulic actuator with the doors represented in dashed lines. The arrows show the direction of rotation and translation of the doors. Stow is in reverse direction.

FIG. 29 shows the motion of the driver link, which is connected to the actuator, to the deploy position. Stow is in reverse direction.

FIG. 30 shows a cross-section of the pivoting point design showing the pivoting axis, the supporting bearing and packing arrangement housed in one of the tailpipe hat sections and attached to a door link.

FIG. 31 shows an isometric view and a side view for the rectangular/trapezoidal doors in the deploy position for the configuration where four actuators are directly connected to the doors replacing the driver link and the tailpipe does not have an internal blister.

FIG. 32 shows a comparison of the impact of the rectangular/trapezoidal flat surface in allowing the majority of the exhaust gases to rebound in the forward direction, as compared with the circular door shape in which exhaust gases bounce back in different directions thereby reducing reverse thrust efficiency and can be conducive to exhaust plume escape and impingement on aircraft surfaces

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

The design concepts included in preferred embodiments of the thrust reverser system include an integrally constructed exhaust tailpipe best illustrated in FIG.1E. The integrally constructed corrugated exhaust tailpipe 1 acts as the main structure carrying the various thrust reverser system components and loads. The thrust reverser loads (in the reverse mode) are transmitted through the tailpipe 1 to the engine bulkhead (not shown), to be bolted to a tailpipe attachment flange 2.

This gas flow leakage from the tailpipe is a major contributor to the deterioration of the overall aircraft/engine system performance, reflected in an increase in fuel consumption and a decrease in range. Tailpipe attachment flange 2, FIG. 1, includes attachment points 9 for the actuators 18. FIG. 7 illustrates in plan view tailpipe 1 wherein the actuator link assembly pivots at point 10 located on the tailpipe integral frame hat section 3. Four link attachment pivot points 10 on the tailpipe are shown. These pivot points connect the doors to the tail pipe frame through links or connecting rods 16.

Another arrangement whereby the tailpipe 1 has no axial internal blister where the actuators 18 are attached to the tailpipe as shown in FIG. 31. In this arrangement each one of the actuators 18 substitutes one of the link assemblies 16 and the actuator itself is used to directly deploy/stow the target doors.

Pivot point 10 is more clearly illustrated in detail in FIGS. 30 and 10. Connecting link 16 attaches to pivot 29 having cylindrical housing 30 for bearing 26, and including packing 27. Housing assembly 10 attaches to hat section 3 by attachment means 28.

FIG. 9 shows an end view of tailpipe 1, forward looking aft through the tail pipe. Attachment flange 2 having actuator attachment points 9 is illustrated and more particularly detailed in FIGS. 8 and 5.

FIGS. 12-19 and FIGS. 20 and 21 illustrate a preferred embodiment for the integral construction of rectangular/trapezoidal clamshell doors 11. The doors consist of rectangular/trapezoidal outer skin 12 and inner skin 13 that can withstand heat. The inner skin 13 preferably has integral frame corrugations 14, comprising two, three or more circular ribs or hats, depending on the loads and the door size. Such design replaces the conventional separate frame construction where structural support usually is riveted between outer and inner skins. The elimination of the conventional frame support results in the elimination of more than half the number of rivets. The present design teaches the direct attachment of the inner skin 13 and the outer skin 12, such as at the trough of the hat sections 14, using appropriate attachment and bonding proces. This reduces weight and manufacturing costs significantly. Again, a strip of material could be attached to the base of the annular channel 14 sections on the interior of the doors, or the hat sections 14 can be attached to the inner skin outer surface using appropriate attachment and bonding process, similar to that disclosed in a preferred design. Inner skin 13

As illustrated in FIGS. 1-11, the integral corrugation construction of tailpipe 1 includes hats or ridges 3, which comprise annular corrugations sometimes referred to as ribs, which can be pressed into the tailpipe material or attached externally to the tailpipe skin, and internal axial blisters or depressions 4, located on each side of tailpipe 1. This integral corrugated design form a cage structure that permits the tailpipe itself to transmit reverse thrust loads directly, in lieu of requiring separate frames to be riveted to the tailpipe skin. The integral ridges and blisters form a cage-like frame upon the skin of the tailpipe itself. This integral construction technique significantly reduces the manufacturing time and cost and results in a lighter and stronger tailpipe. The hat or rib sections 3 act as the traditional Z or L-sections, by providing twice as much rigidity as traditional Z or L-sections without incurring the weight penalty. If acoustic attenuation is needed, as illustrated in the preferred embodiment in FIG. 3, especially for turbojet or low bypass applications, a similar tailpipe design can be utilized where a bonded honeycomb 5, or whatever sound attenuation material is desired, can be sandwiched between a smooth tailpipe outer skin 6 and an inner corrugated tailpipe perforated skin 7, having an inside surface 1i and an outside surface 1e. Skin 7 maintains the integrally constructed corrugated tailpipe structure of the tailpipe of FIG. 1. Skins 6 and 7 and the sound attenuation material 5 are to be sandwiched and attached together using an appropriate attachment process, depending on the materials used for construction. The hat section areas 3 of skin 7 and the axial depressions 4, would not have any perforations 7A, to enhance structural integrity. Other configurations could be made where the corrugations could be in the outer skin 6 which is attached or fastened to the inner skin 7, enclosing the sound attenuation material between them as before.

A strip of material 8, or any other compatible material depending on the material used for construction, could be attached to the inside surface 1i of tailpipe 1, under hat sections 3, in areas exposed to internal flow to enhance internal gas flow characteristics and increase rigidity, if needed. See FIG. 5. The tailpipe surface in the internal gas flow path area will be generally smooth and continuous, except for the base areas of hat sections 3, which are essentially insignificant. Importantly, the contact surface for the internal gas flow through the reverse thrust system is comprised of the unitary tailpipe 1 itself and thus does not allow for any leakage or interruption of the exhaust gas flow, which in turn requires elaborate sealing designs and still results in exhaust flow leakage of several percent with time and stack-up of hardware tolerances.

includes a kicker end plate 15, located at the forward end of each door (when stowed), to further divert the reversed flow of gases in the reverse mode. Four connecting rods, or links, 16 connect each door 11 to actuators 18 and tailpipe 1, illustrated in FIG 26. The links are shown connected to the doors using four fittings 24 bolted to portions of the inner door skin 13, as shown more particularly in FIG. 16 and 17. Illustrated in FIG. 15,18 and 19 is the elimination of conventional fairings on the sides of the thrust reverser doors and incorporating those fairings into the integral construction of the doors 11, as done with the circular ULTRA REVERSER SYSTEM. The fact that the doors in the SQUARE ULTRA design have a flat surface for the exhaust flow from the tailpipe to bounce on, this inner skin door configuration helps the majority of the reverse flow to deflect forward in the same general plane as the incoming flow and the same direction of motion of the aircraft, as shown in FIG. 32. The inner skin of circular doors due to the curvature of the surface, causes the reverse flow to bounce in different directions which is conducive to lateral exhaust plumes impinging on the aircraft surfaces and not necessarily contributing to the primary function of reversing the flow to decelerate the aircraft. The two flat sides of the door act as a buffer to minimize exhaust plume escape in the lateral direction and impingement on the aircraft. Current designs use different shapes of fairings to cover the actuators and actuation mechanism on the side of the tailpipe, in addition provide for the protrusion of the fairings into the free air stream. The elimination of separate individual fairings is achieved by extending the upper and lower doors outer and inner skins, referred to in combination as element 17, to form rectangular/trapezoidal doors to cover actuators 18, as shown also in FIGS. 20 and 21. An important further benefit of this idea is providing extensions 17 on the doors as an additional barrier between the reversed internal engine gases and the aircraft surface to control and contain the reverse flow plume and keep it away from aircraft surfaces. This will also help keep the flow attached to the doors for an extended period of time in the deployed position to further guide the flow forward to achieve the desired reverse thrust. This approach eliminates the cost of the fabrication and tooling of the conventional fairings and decreases gaps between doors and fairings significantly, which gaps have the potential to cause aerodynamic losses. The incorporation of the conventional fairings into the door construction also saves the weight and cost of the fairings attachment to the structure.

In the preferred embodiment in FIGS. 15, 18, 19, 20 and 21 is extension 19 of the inboard and/or outboard side of either an upper and/or lower door. Such extension 19 would be used, as systems integration and compatibility demands, to further divert the exhaust plume in reverse away from the aircraft surface to enhance its stability on the ground during reverse thrust operation. The extension 19 is shown designed to underlap the edge of the other door in the stowed position, FIGS. 20 and 21, adjacent the actuators 18 received in the tailpipe 1 blisters 4.

As in the ULTRA REVERSER SYSTEM, the SQUARE ULTRA can use a pressure booster 20 for the reverser actuators 18, schematically shown in FIGS. 22 and 25. Customarily hydraulic or pneumatic pressures are used to actuate thrust reverser systems. The idea of boosting pressure could be applied to any type of working fluid. For discussion purposes, the case of hydraulic fluid is used. A hydraulic pressure booster 20 could be installed internally in any section of the aircraft to increase the hydraulic pressure from the aircraft supply, which is usually at 1500-3000 psi. The hydraulic pressure supply to the thrust reverser actuators can be boosted up to 8000 psi or beyond as the technology advances and as sealing technology permits, to meet the most critical reverser need which is usually a restow due to an inadvertent deployment during flight, or as specified by the design or certification requirements. As certification requirements become more stringent and require the ability to restow at increasingly higher speeds, the actuators will tend to become bigger and take more space in the nacelle. This booster approach reduces the necessary size of the hydraulic actuators to be located in the blisters 4 on each side of the tailpipe, which in turn allows each actuator to be housed in a smaller internal tailpipe blister 4 area, thereby minimizing impact on the internal gas flow, or the corner of the door as in the alternate configuration shown in FIG. 31, thereby avoiding protrusion in the free stream. This approach contributes to the optimization of the overall aerodynamic performance of the thrust reverser system due to the significant reduction of various types of drag (friction, base drag, interference drag). Another benefit of using a hydraulic pressure booster is the ability to maintain commonality of actuator sizes, regardless of the aircraft hydraulic pressure supply, while compensating for the aircraft hydraulic pressure supply in the booster design. This system allows using the same reverser and actuators for several aircraft applications in which each aircraft may have a different hydraulic pressure supply rating, hence allowing the same design to lend itself to

multiple applications. The booster will be sized to meet the specific restow requirements which are primarily a function of the doors area and loads.

The SQUARE ULTRA design utilizes the same idea of the ULTRA REVERSER SYSTEM, illustrated in FIGS. 12 and 26, which is the sliding rearward of a portion 22 of an aft fairing attached to a tailpipe 1, preferably movable portion located on each side of the tailpipe. The driving force may either be through mechanical linkages, or actuated electrically, pneumatically or hydraulically during a deployment cycle. The remainder immobile portion 23 of the aft fairing would be attached to the tailpipe to maintain the external contour line during forward flight mode. Movable aft fairings, 22 as a tail pipe extension, may be spring loaded to keep them retracted during forward flight mode. Movable aft fairings, 22 as a tail pipe extension, may be be spring loaded to keep them retracted during forward thrust and to maintain the external contour lines. The movable aft fairings 22 would move rearward, when needed, to close the small gap between the tailpipe exit plume and the clamshell doors in the deployed, reverse thrust position. This feature keeps the reverse flow enclosed between the deployed doors and the tailpipe to direct the reverse flow along the door's inner walls and forward to achieve the desired reverse thrust and deceleration. The fairings 22 would be in contact with the relatively cooler and higher pressure by-pass flow; therefore, they could be made out of aluminum, for example.

A pocket extremely high turbulence flow is generated in the vicinity where both doors meet at the end of the deployment stroke for target type reversers. The turbulence is the result of the interaction between the hot gases flowing from the tailpipe rearward and the reverse flow gases rebounding from the inner doors surface. Another benefit of a movable aft fairing portion 22 is using it for alleviation and control of the effect of this highly turbulent flow by controlling the gap between the sliding aft fairing and the doors. It could be set, during flow test, to allow some of the highly turbulent gases to escape to improve the flow characteristics of the rest of the gases along the doors to provide the reverse flow action. The released gases are insignificant, but could have a favorable impact on reverse thrust performance and efficiency. Reverse thrust efficiency translates into less power from the engine during reverse thrust mode, which can lead to a reduction in the engines' cycle count, extension of the time between the engine overhauls and extension of engine components service life due to reduction in accrued operating cycles. The gases would not be allowed to impinge on any of the aircraft control surfaces or critical areas.

In operation, the reverse thrust action aims at slowing down the aircraft after landing or is used for backing up and braking action during taxiing operations. When reverse thrust is commanded, the clamshell doors 11 will be pushed rearward by the actuators, or through a connecting linking mechanism, to a position aft of the exhaust tailpipe exit area to divert the exhaust flow of the engine forward to slow down the aircraft from its landing speed, down to a manageable taxiing speed.

In the preferred design, the force resulting from the exhaust flow impingement on the doors will be absorbed by either the links or the actuators, which in turn transfer the loads onto the tailpipe integral frames, skin and blister structure, which transfer the load to the engine or nacelle bulkhead through a bolted flange.

Boosted hydraulic pressure supply to the thrust reverser actuators would result in the reduction of their respective diameters, thereby minimizing the impact of the tailpipe internal blister housing the actuator system on the internal engine exhaust gas flow path. Even with conventional designs, smaller actuators would help eliminate the need for external blisters protruding in the free air stream. Fairing protrusion in the free air stream to cover the actuation system results in external drag increase leading to a several percent increase in SFC during normal cruise.

The elimination of the separate side fairings achieved by extending the doors to cover the actuation system, as used in the ULTRA THRUST REVERSER DESIGN, also helps effectively enclose the jet flow within the door during reverse mode and prevent it from escaping towards aircraft control surfaces, due to having straight side surfaces for the door instead of circular one as used in other designs. The elimination of the separate side fairings also helps eliminate any need to have external provisions in the free stream to divert any escaped plume away from the aircraft control surfaces.

The foregoing disclosure and description of the invention are illustrative and explanatory thereof, and various changes in the size, shape, and materials, as well as in the detail of the illustrated system may be made without departing from the spirit of the invention.

CLAIMS

What is claimed is:

1. A thrust reverser system for a jet engine, comprising:

a tailpipe having an internal surface in contact with engine internal gas flow, and an outer surface;

a pair of clamshell-type doors, each door comprising a substantially flat center panel, an inboard side panel extending from an inboard longitudinal edge of the center panel, and an outboard side panel extending from an outboard longitudinal edge of the center panel;

said doors moveable between a stowed position, overlaying the tailpipe and out of contact with internal gas flow, and a deployed position, behind the tailpipe, wherein a majority of the internal gas flow impinges directly upon the door center panels.

2. The thrust reverser system of claim 1, wherein the doors contact each other along longitudinal free edges of the side panels when in stowed position, thereby fully surrounding the tailpipe.

3. The thrust reverser system of claim 2, wherein the inboard and outboard side panels are substantially flat.

4. The thrust reverser system of claim 3, wherein the side panels extend at right angles from the center panel, such that both doors together in stowed position define a substantially rectangular cross-section.

5. The thrust reverser system of claim 3, wherein the angle between the side panels and the center panels is substantially greater than a right angle, such that both doors together in stowed position define a hexagonal cross-section.

6. The thrust reverser system of claim 1, further comprising a system of actuators and linkages attached between the tailpipe outer surface and the doors.

7. The thrust reverser system of claim 6, wherein the system of actuators and linkages comprise for each door at least one hydraulic actuator directly linking the tailpipe outer surface to the door.

8. The thrust reverser system of claim 7, wherein the at least one hydraulic actuator is positioned within a cavity between the door and the tailpipe outer surface when the door is in stowed position.

9. The thrust reverser system of claim 7, wherein the at least one hydraulic actuator is positioned within a depression in the outer surface of the tailpipe.

10. The thrust reverser system of claim 6, wherein the system of actuators and linkages comprises, for each door, a pair of pivotally mounted hydraulic actuators directly linking the tailpipe outer surface to the door, and a pair of pivotally mounted rods directly linking the tailpipe outer surface to the door.

11. The thrust reverser system of claim 6, wherein the system of actuators and linkages comprises, for each door, two pair of pivotally mounted hydraulic actuators directly linking the tailpipe outer surface to the door.

21. A thrust reverser system for a jet engine, comprising:

a tailpipe having an internal surface in contact with engine internal gas flow, and an outer surface;

a pair of reverser doors, each door comprising forward and aft ends, and a substantially flat center panel;

said doors moveable between a stowed position, overlaying the tailpipe, and out of contact with internal gas flow, and a deployed position, disposed behind the tailpipe in abutting relation along their aft ends, and wherein a majority of the internal gas flow impinges directly upon the flat center panels.

22. The thrust reverser system of claim 21, wherein the reverser doors further comprise inboard and outboard side panels extending from opposed longitudinal edges of the certain panels.

23. The thrust reverser system of claim 22, wherein the side panels are at substantially right angles to the center panels.

24. The thrust reverser system of claim 22, wherein, in deployed position, the flat center panels are positioned substantially perpendicular to the impinging internal gas flow.

25. The thrust reverser system of claim 21, further comprising a first pair of hydraulic actuators directly linking each door to the tailpipe outer surface, and configured to move the doors between the stowed and deployed positions.

26. The thrust reverser system of claim 25, further comprising a second pair of hydraulic atuators directly linking each door to the tailpipe outer surface, and configured to move the doors between the stowed and deployed positions.

31. A thrust reverser system for a jet engine, comprising:

a tailpipe having an internal surface in contact with engine internal gas flow, and an outer surface;

a pair of reverser doors, each door comprising forward and aft ends, and a substantially flat center portion;

at least one hydraulic actuator directly linking each reverser door to the tailpipe outer surface;

said doors moveable between a stowed position, overlaying the tailpipe, and out of contact with internal gas flow, and a deployed position, disposed behind the tailpipe in abutting relation along their aft ends, and wherein said flat center portion deflects the internal gas flow.

32. The thrust reverser system of claim 31, wherein said at least one hydraulic actuator comprises a first pair of hydraulic actuators.

33. The thrust reverser system of claim 32, further comprising a second pair of hydraulic actuators directly linking each reverser door to the tailpipe outer surface.

34. The thrust reverser system of claim 31, wherein the reverser doors further comprise substantially flat inboard and outboard side panels.

35. The thrust reverser system of claim 31, wherein the inboard and outboard side panels extend at a right angle from the door center portions.

36. The thrust reverser system of claim 34, wherein the reverser doors fully surround the tailpipe when in stowed position.

ABSTRACT OF THE DISCLOSURE

A thrust reverser system for jet engine comprising a tailpipe, Square/trapezoidal clamshell doors and actuators, wherein the tailpipe and clamshell doors may be corrugated, the corrugations can be mating, the actuators may be situated out of the external free air flow, the doors may be stowed out of contact with internal engine gas flow and that may include a tail pipe aft fairing having a movable section.

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CONFIRMATION NO. 8228

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Tempe, AZ 85282

FORMALITIES LETTER

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Date Mailed: 01/24/2005

NOTICE OF INCOMPLETE NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

A filing date has NOT been accorded to the above-identified application papers for the reason(s) indicated below.

All of the items noted below **and a newly executed oath or declaration covering the items must** be submitted within **TWO MONTHS** of the date of this Notice, unless otherwise indicated, or proceedings on the application will be terminated *(37 CFR 1.53(e))*. Replies should be mailed to: Mail Stop Missing Parts, Commissioner for Patents, P.O. Box 1450, Alexandria VA 22313-1450.

The filing date will be the date of receipt of all items required below, unless otherwise indicated. Any assertions that the item(s) required below were submitted, or are not necessary for a filing date, must be by way of petition directed to the attention of the Office of Petitions accompanied by the $130.00 petition fee *(37 CFR 1.17(h))*. If the petition states that the application is entitled to a filing date, a request for a refund of the petition fee may be included in the petition. Petitions should be mailed to: Mail Stop Petitions, Commissioner for Patents, P.O. Box 1450, Alexandria VA 22313-1450.

- The application was deposited without drawings. 35 U.S.C. 113 (first sentence) requires a drawing "where necessary for the understanding of the subject matter sought to be patented." *Applicant should reconsider whether the drawings are necessary under 35 U.S.C. 113 (first sentence).*

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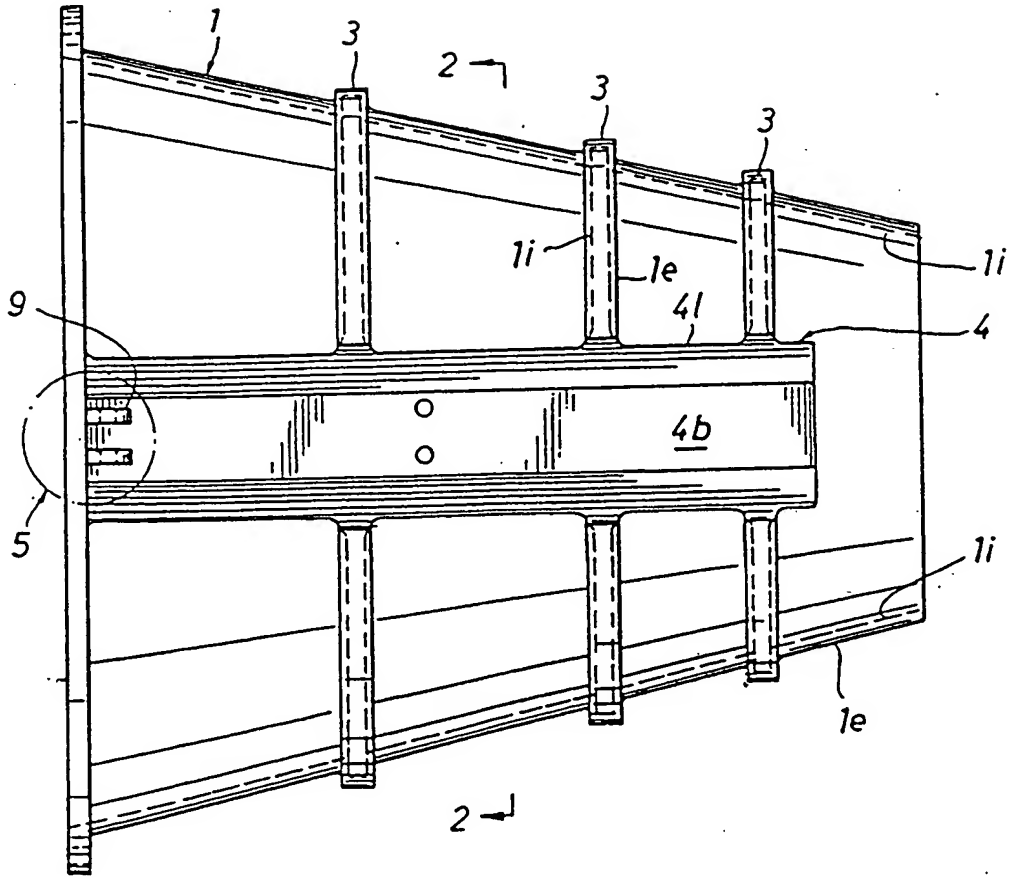


FIG. 1

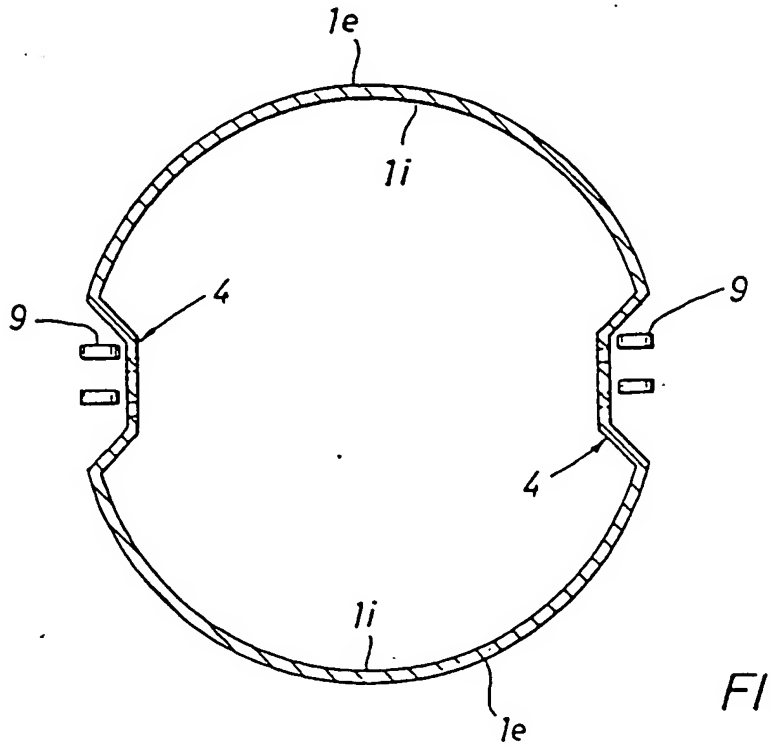


FIG. 2

FIG. 3

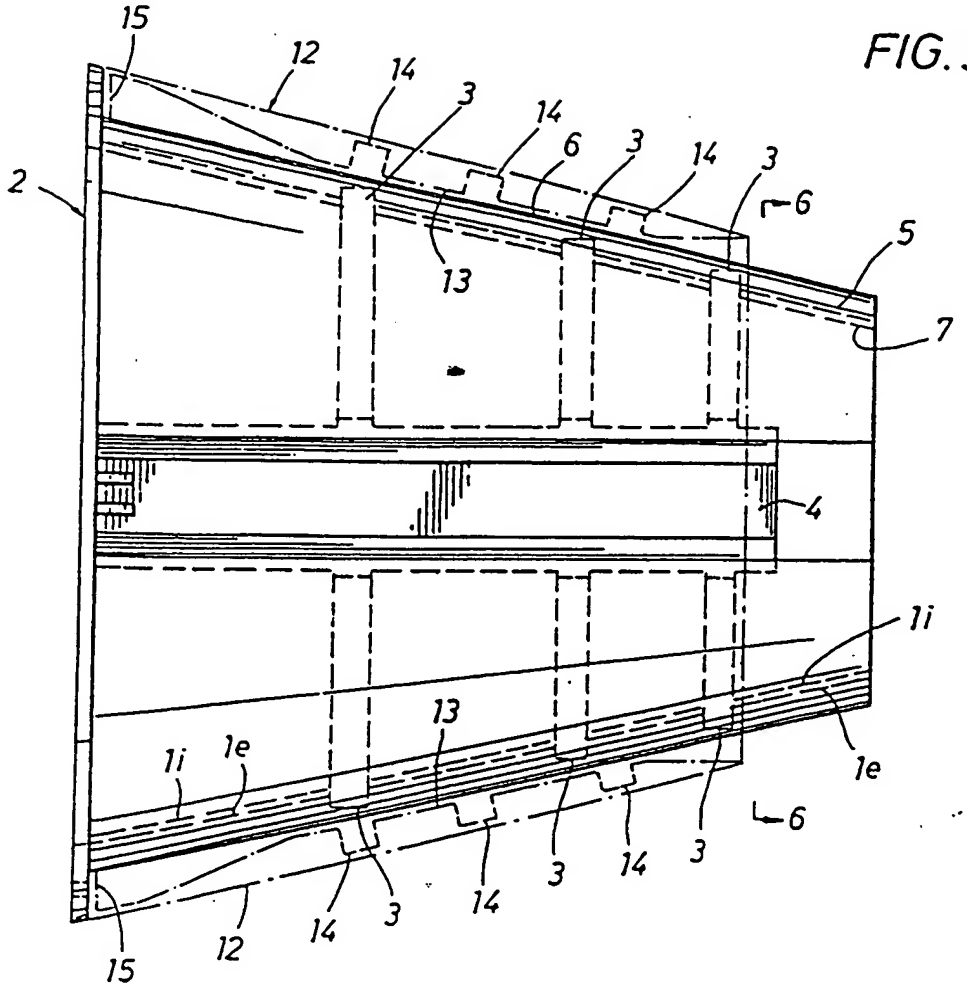
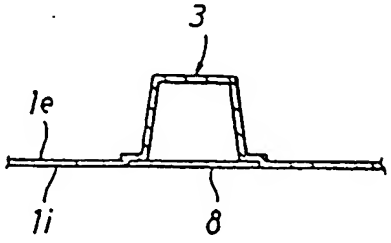


FIG. 4



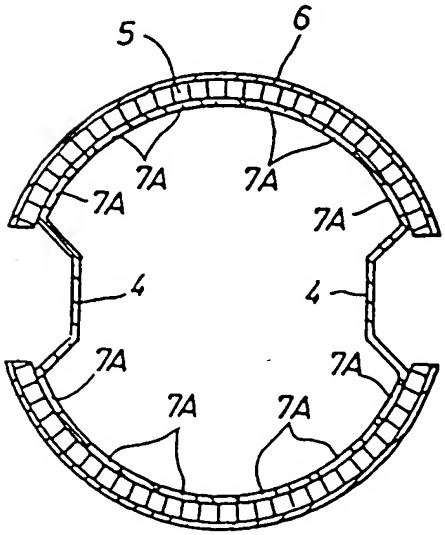


FIG. 6

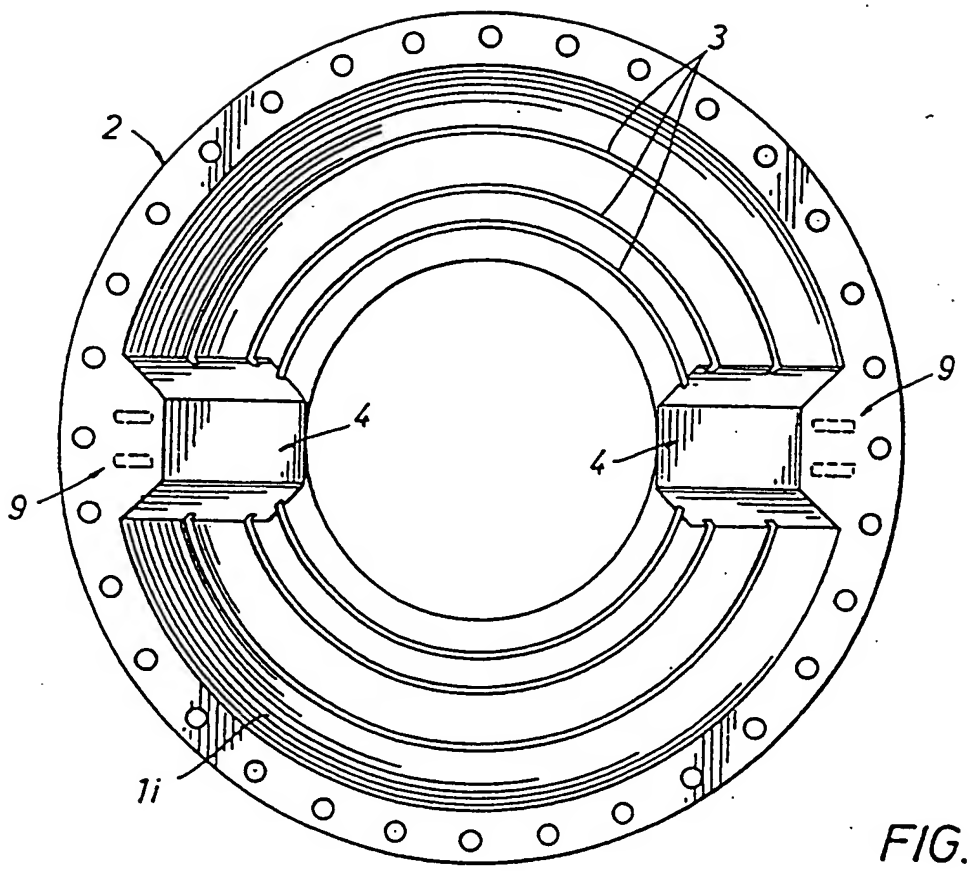
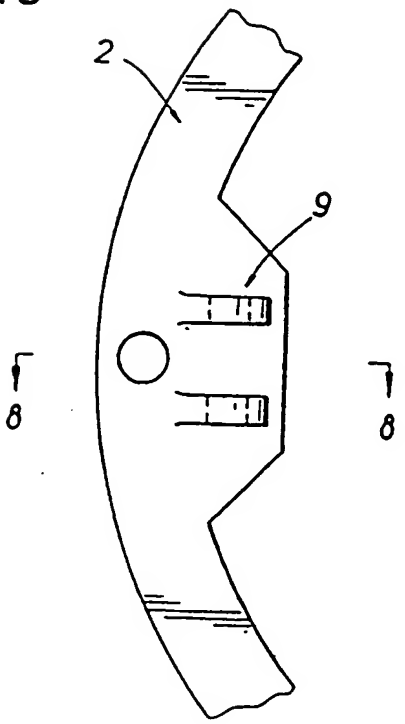


FIG. 9

FIG. 5



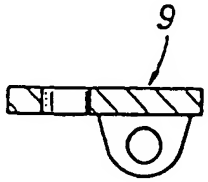


FIG. 8

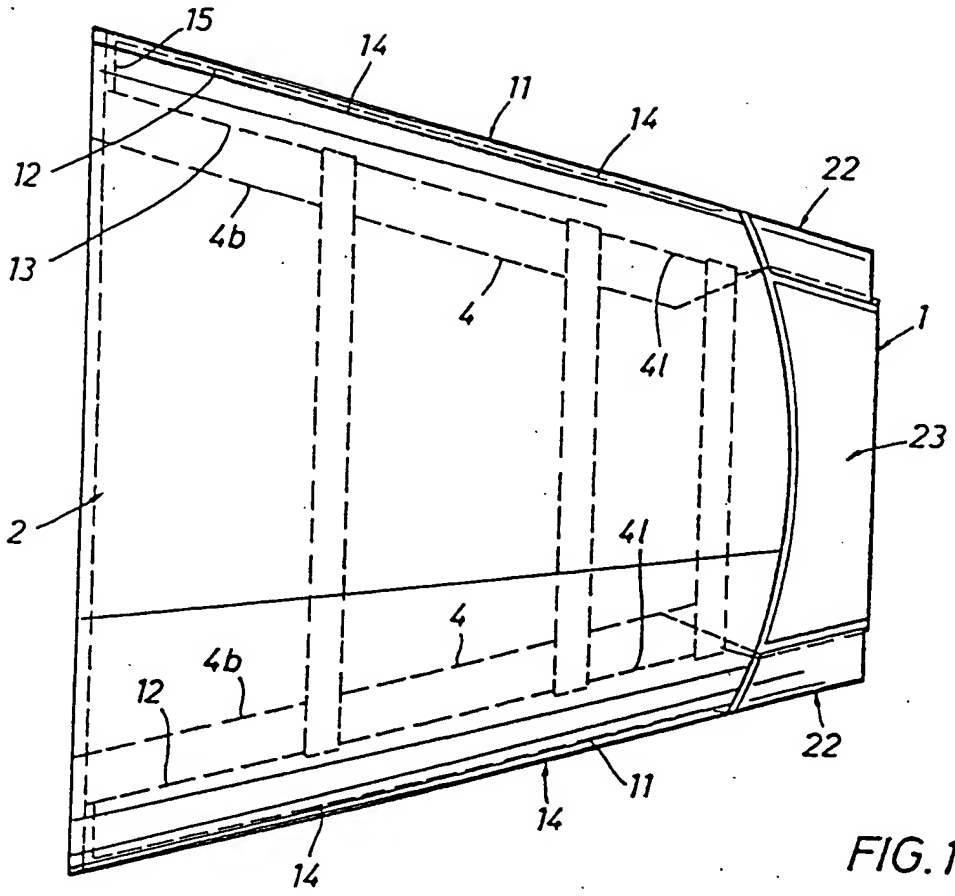


FIG. 13

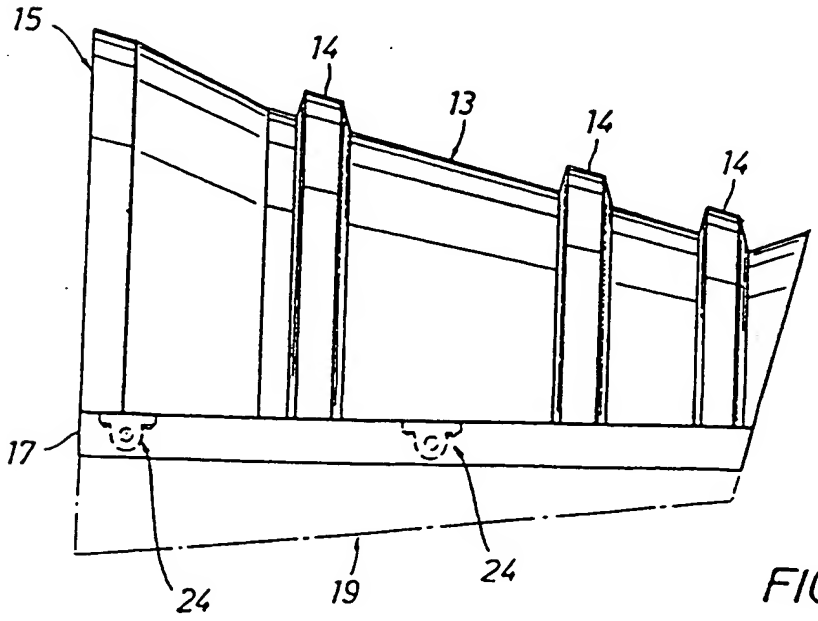


FIG. 18

FIG. 7

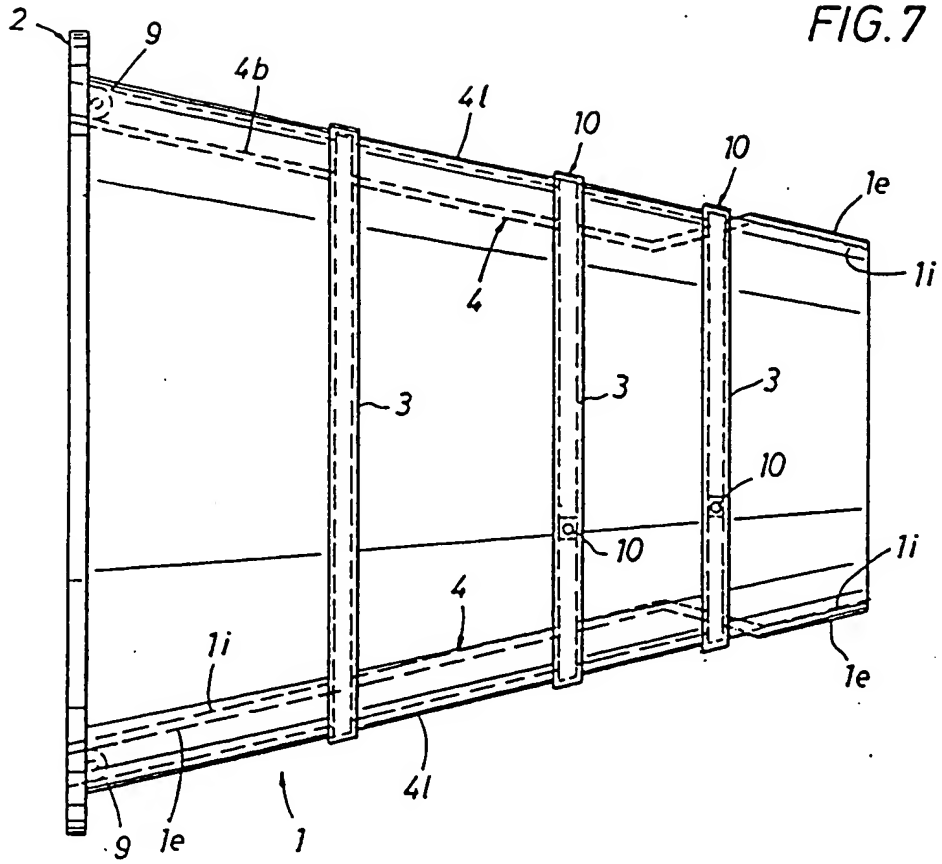
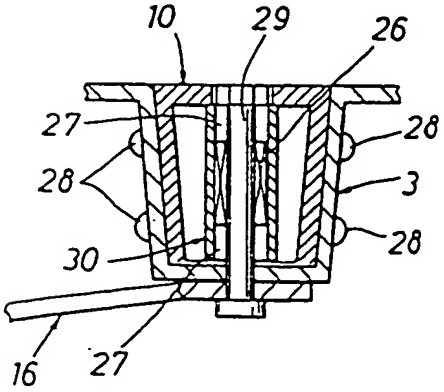


FIG. 30



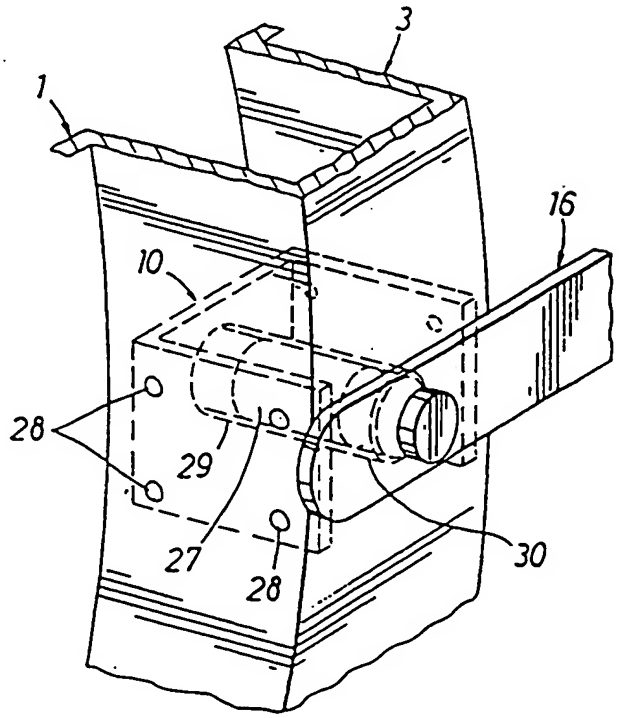


FIG. 10

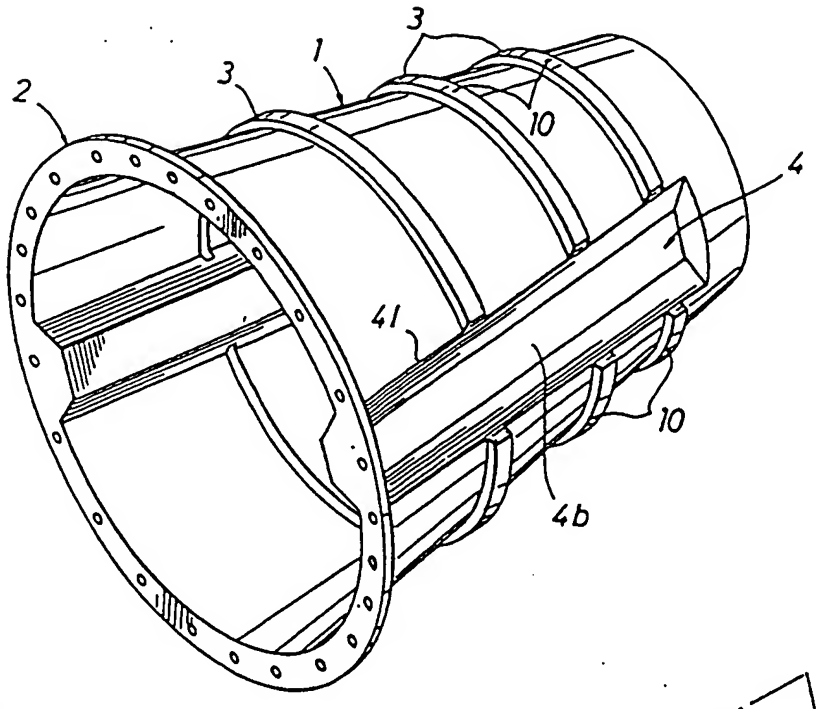


FIG. 11

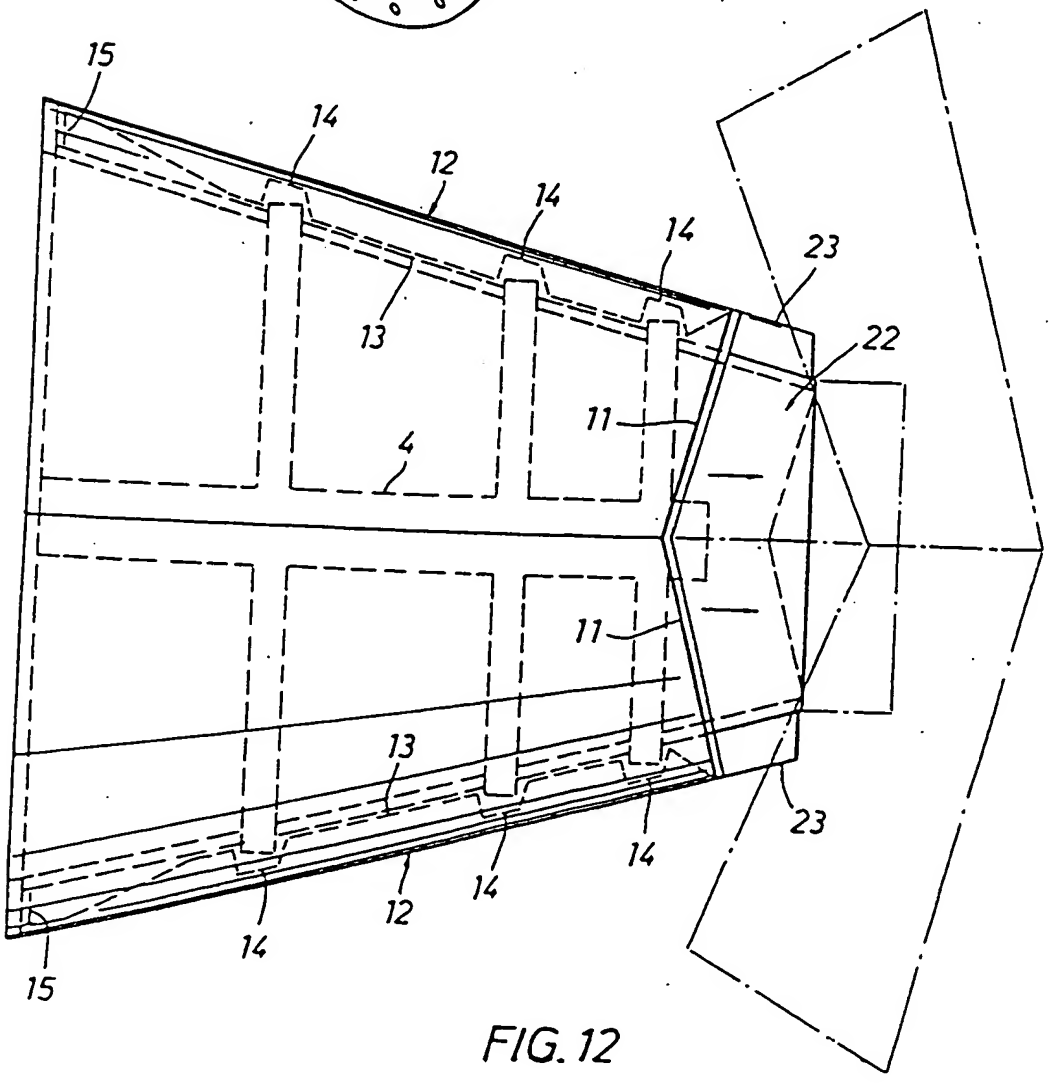
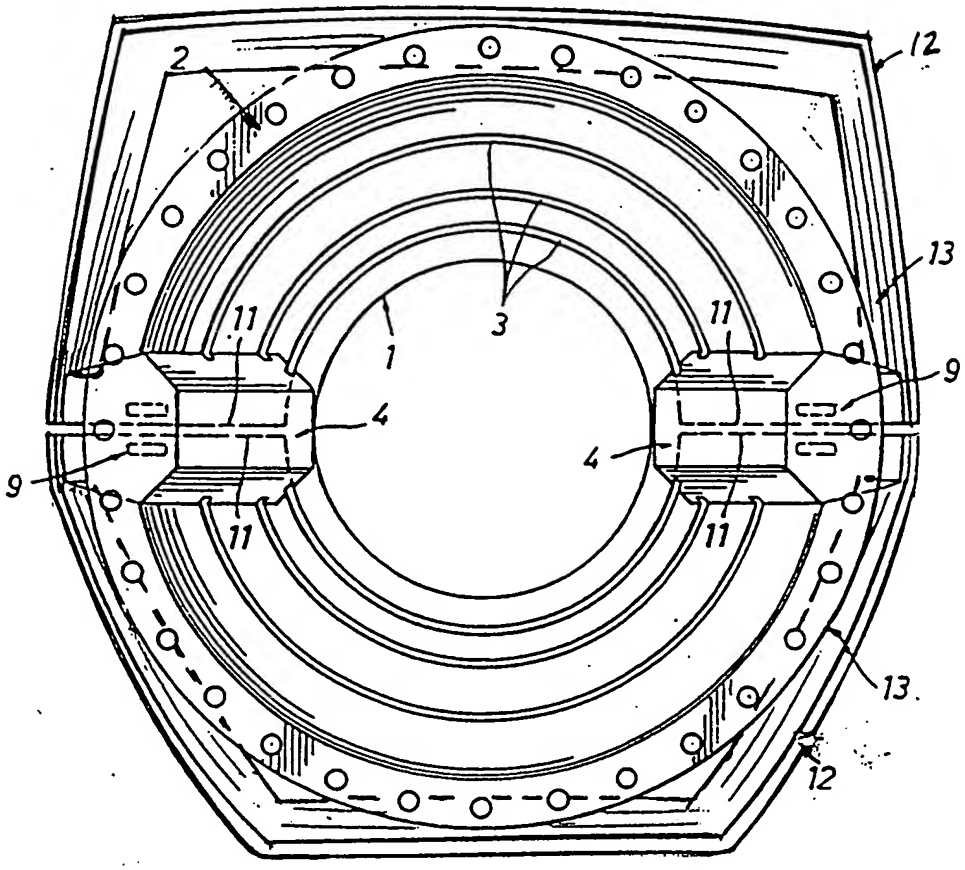


FIG. 12

FIG. 14



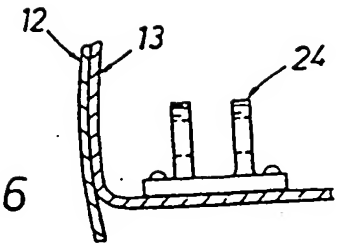


FIG. 16

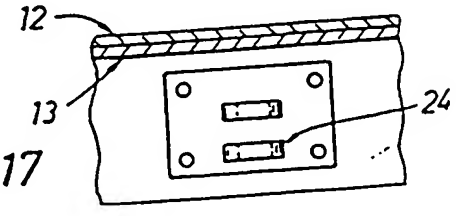


FIG. 17

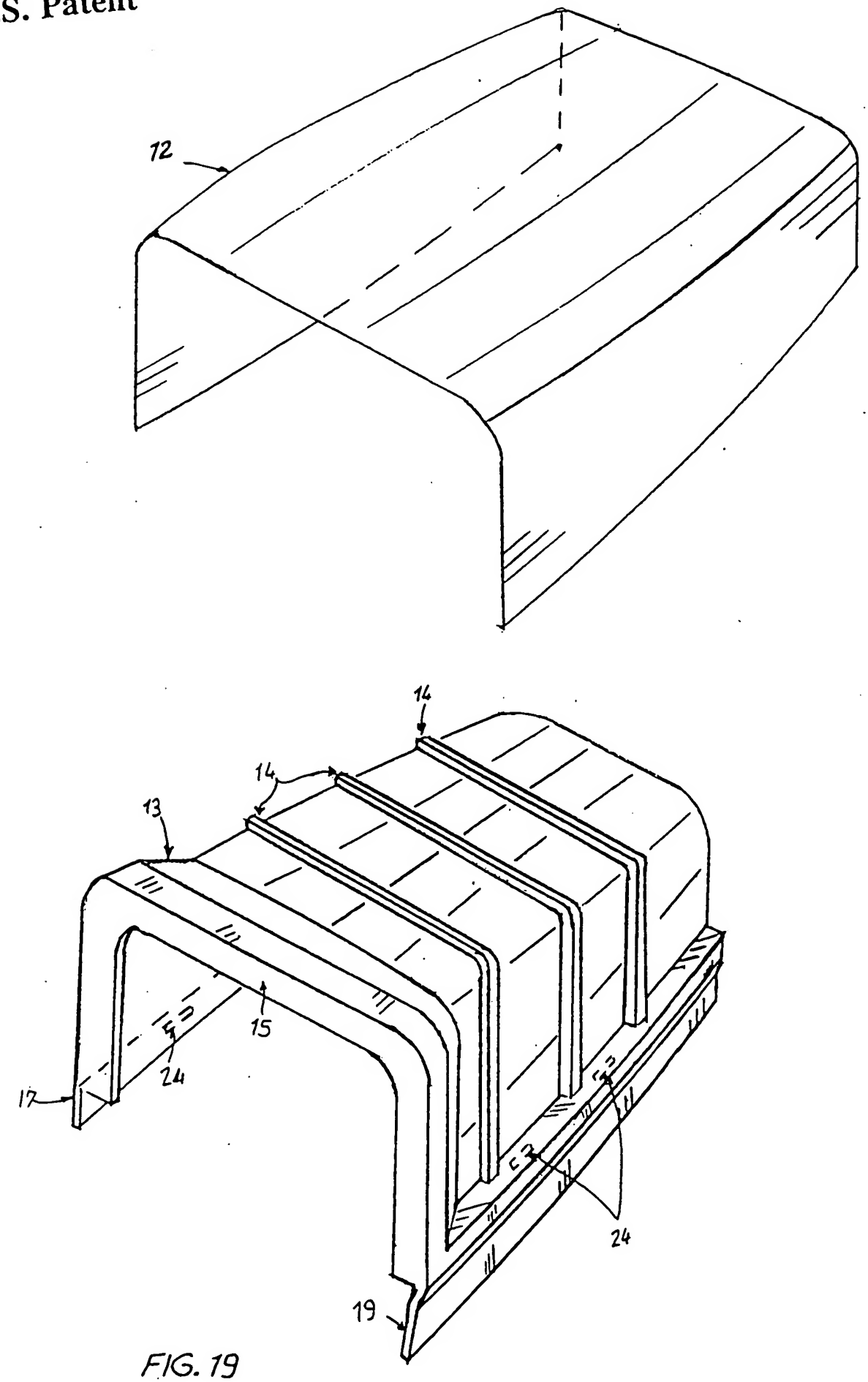


FIG. 19

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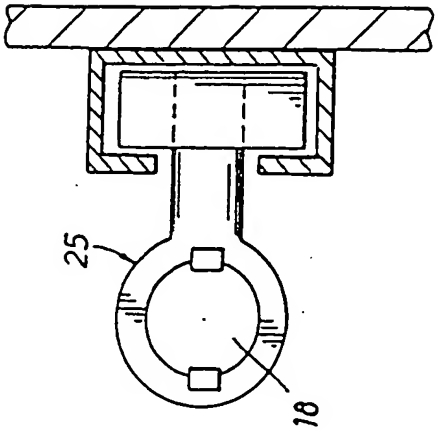


FIG. 24

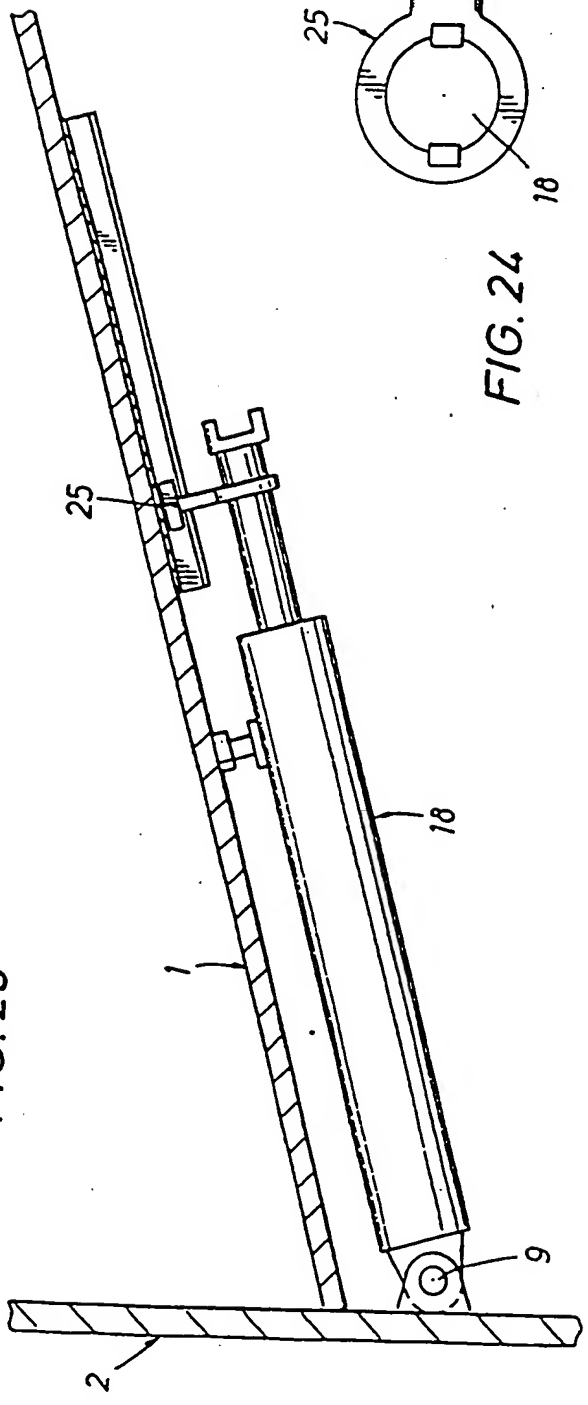


FIG. 23

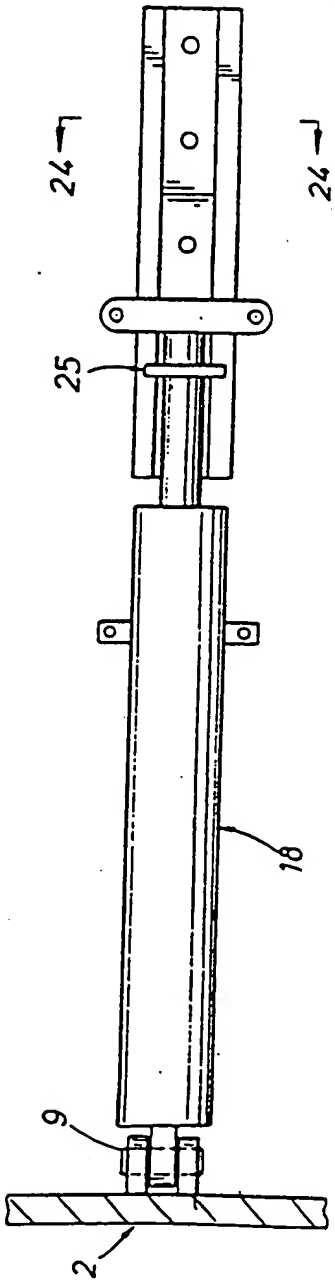


FIG. 22

FIG. 25

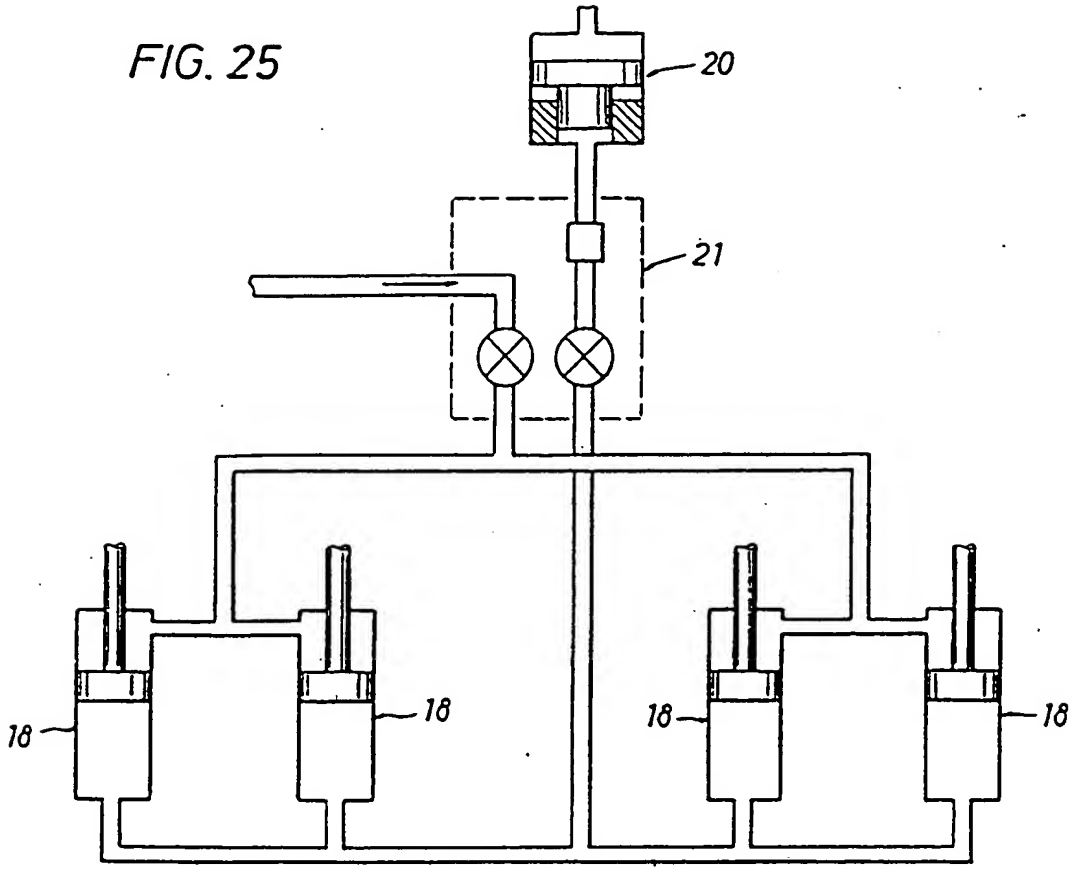


FIG. 26

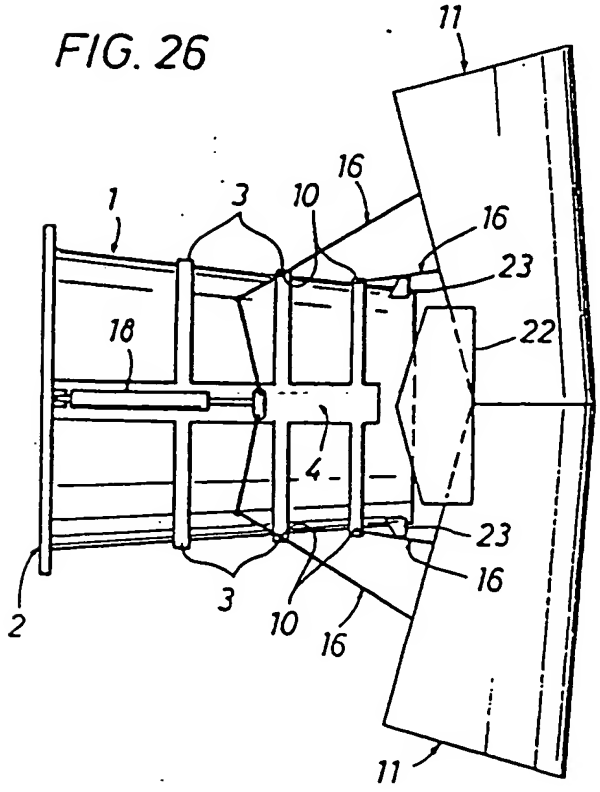
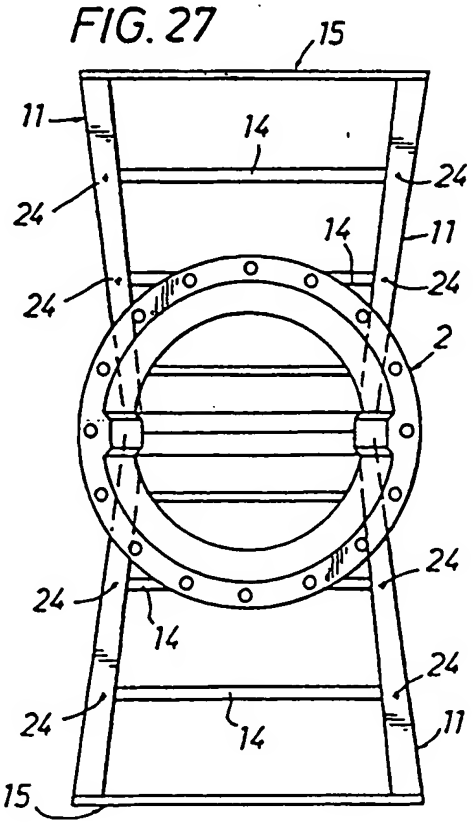


FIG. 27



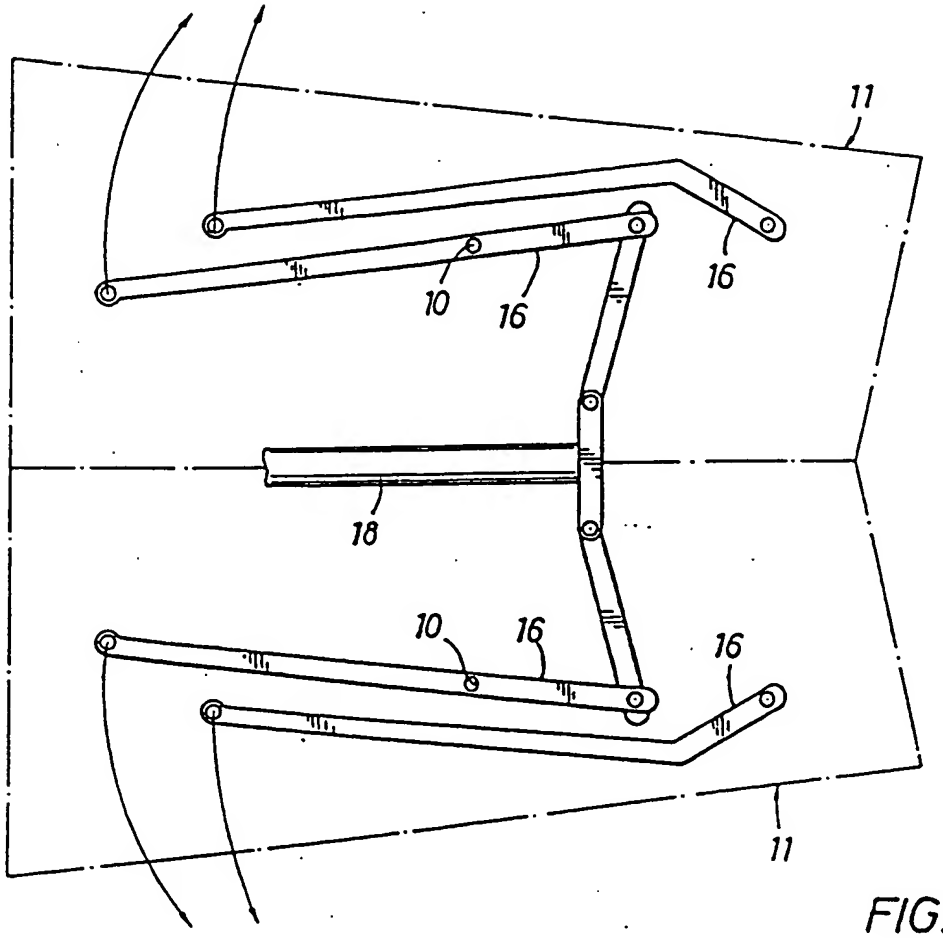


FIG. 28

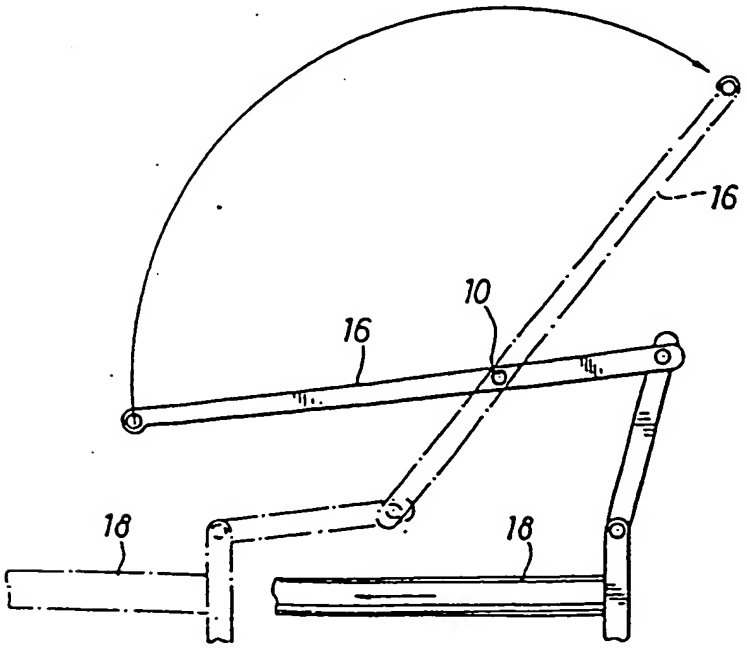


FIG. 29

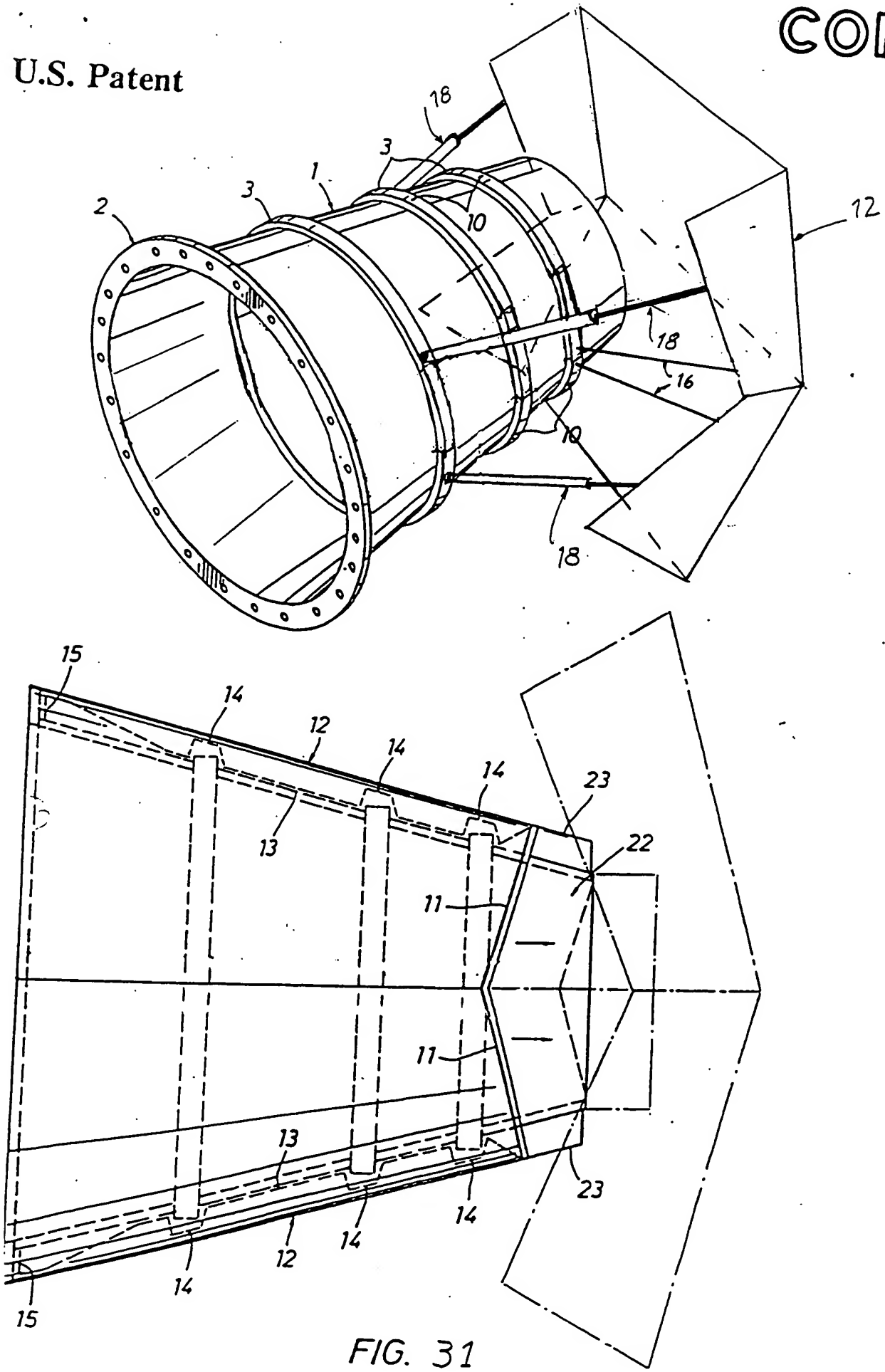

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FIG. 31

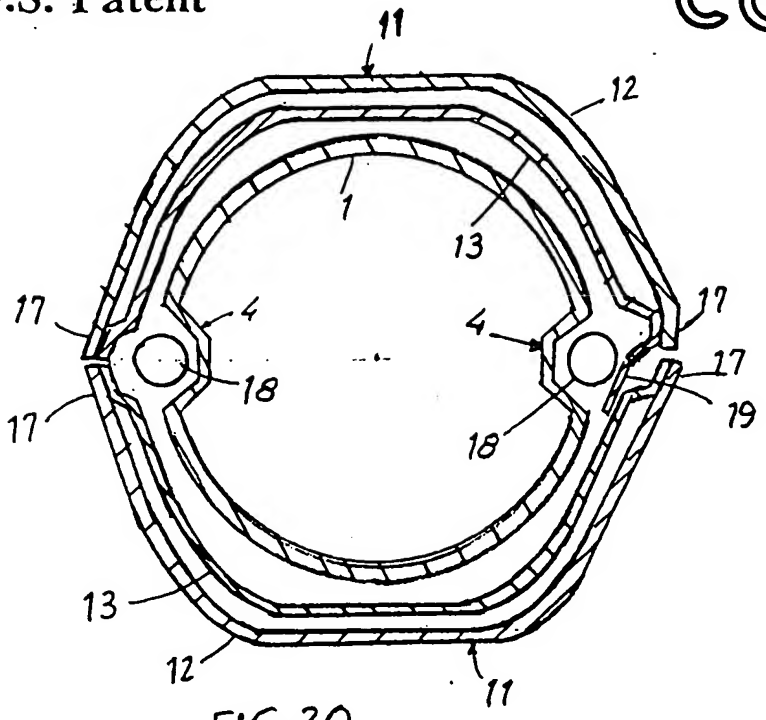


FIG. 20

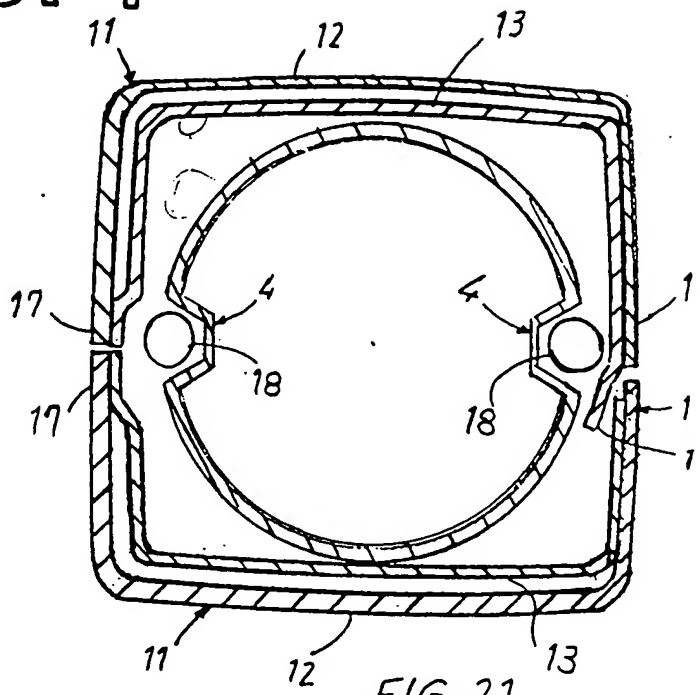


FIG. 21

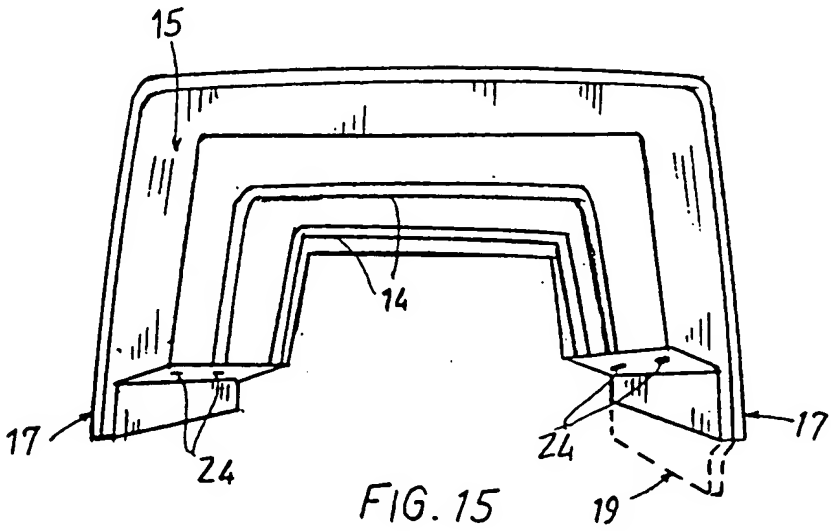
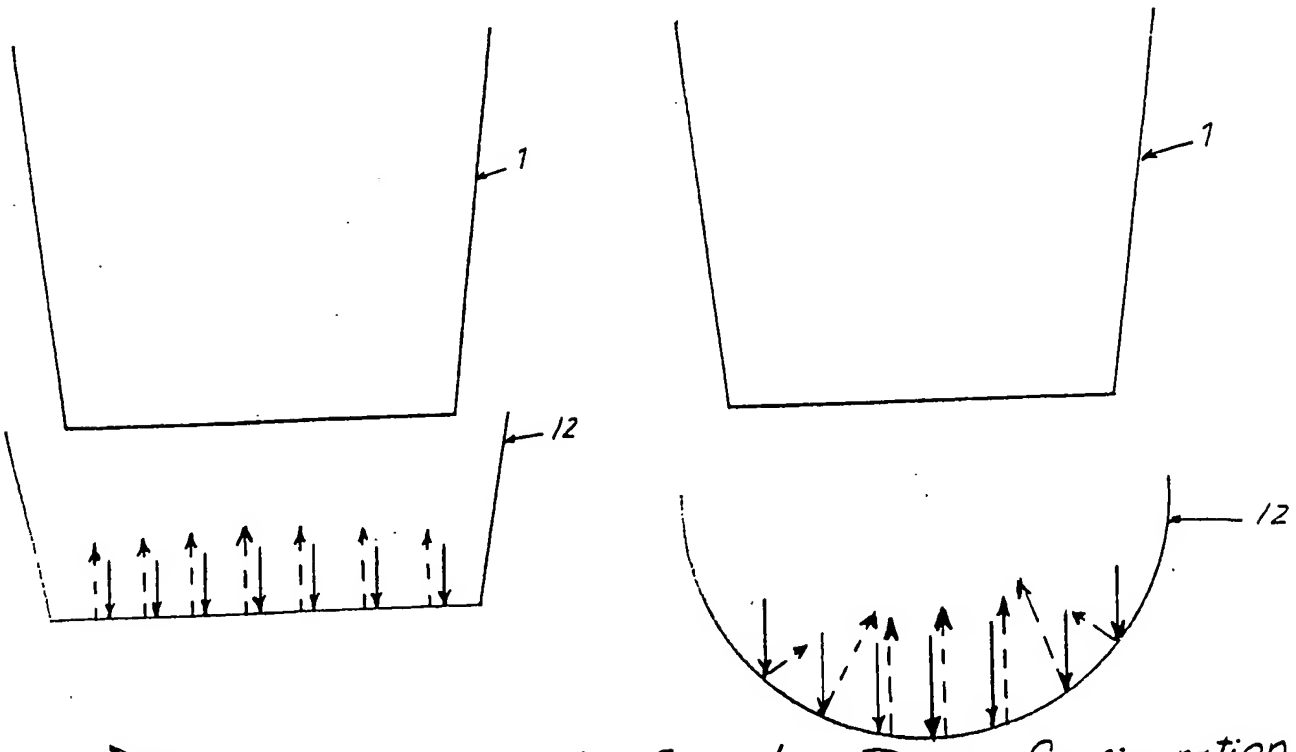


FIG. 15

——→ Exhaust Gas From Tailpipe

- - - → Reverse Flow Bouncing off Door



Square vs. Circular Door Configuration

FIG. 32